

# **Module Manual**

Master of Science (M.Sc.)

# Civil Engineering Dual study program

Cohort: Winter Term 2024 Updated: 26th June 2024

# **Table of Contents**

Program description         5           Corce Qualification         7           Module M0523: Business & Management         7           Module M1756: Practical module 1 (dual study program, Master's degree)         10           Module M1766: Practical module 1 (dual study program, Master's degree)         10           Module M1024: Finite elements         11           Module M1024: Finite elements         11           Module M1024: Finite elements         11           Module M1024: Finite elements         12           Module M004: Constructions         13           Module M004: Underground Constructions         13           Module M004: Constructions and Building Preservation         26           Module M004: Construction Robucis         23           Module M004: M004: Sulding Master Management         33           Module M004: Under ground Constructions         34           Module M004: W004: Under ground Construction Project Management         35           Module M004: W004: W00	Table of Conte		2
Module M0522: Busines & Management         7           Module M1256: Practical module 1 (dual study program, Master's degree)         8           Module M1256: Practical module 1 (dual study program, Master's degree)         10           Module M2024: Finite elements         14           Module M1256: Practical module 2 (dual study program, Master's degree)         15           Module M1257: Practical module 2 (dual study program, Master's degree)         17           Specialization Coastal Engineering         19           Module M0596: Geotechnics III         19           Module M0595: Digital Twinning In Civil Engineering         23           Module M0593: Building Materias and Building Preservation         26           Module M0593: Building Materias and Building Preservation         30           Module M0593: Building Materias and Building Preservation         33           Module M0756: Soil Mechanics and -Dynamics         30           Module M0757: Construction Rogiest management         33           Module M0756: Soil Mechanics and Project Management         33           Module M0757: Construction Project         31           Module M0757: Construction Project         33           Module M0757: Construction Project         33           Module M0757: Construction Project         33           Module M0758: Statianable energy from wi			5
Module M1255: Unking theory and practice (dual study program, Master's degree)     8       Module M1257: Practical module 1 (dual study program, Master's degree)     12       Module M1257: Practical module 2 (dual study program, Master's degree)     13       Module M1257: Practical module 2 (dual study program, Master's degree)     15       Module M1257: Practical module 2 (dual study program, Master's degree)     17       Specialization Coastal Engineering     19       Module M0864: Underground Constructions     21       Module M0864: Underground Constructions     23       Module M0865: Digital Twinning in Civil Engineering     28       Module M0255: Soil Mechanics and -Opnamics     30       Module M0255: Soil Mechanics and -Opnamics     30       Module M0255: Soil Mechanics and -Opnamics     33       Module M0255: Soil Mechanics and -Opnamics     33       Module M0255: Soil Mechanics and -Opnamics     33       Module M0252: Urban Environmental Management     33       Module M0252: Urban Environmental Management     35       Module M0252: Urban Environmental Management     30       Module M0255: Soil Mechanics and Project Management     35       Module M0355: Statics and Dynamics of Structures     30       Module M0355: Statics and Dynamics of Structures     30       Module M0355: Statics and Dynamics of Structures     30       Module M0355: Statics and Dynamics of			
Module M1256: Practical module 1 (dual study program, Master's degree)     10       Module M2024: Finite elements     14       Module M2024: Finite elements     14       Module M1257: Practical module 2 (dual study program, Master's degree)     15       Module M1257: Practical module 2 (dual study program, Master's degree)     17       Specialization Coastal Engineering     19       Module M0596: Gentechnics III     19       Module M0595: Digital Twinning in Civil Engineering     23       Module M0595: Digital Twinning in Civil Engineering     25       Module M0595: Digital Twinning in Civil Engineering     30       Module M0595: Building Materias and Building Preservation     30       Module M0593: Building Materias and Building Preservation     30       Module M0756: Soll Mechanics and -Dynamics     30       Module M0767: Masterwater Systems     30       Module M0877: Construction Engineering     37       Module M0877: Construction Engineering     37       Module M0877: Construction Project Management.     33       Module M0877: Construction Project Management.     33       Module M0877: Construction Project Management.     33       Module M0878: Statica and Dynamics of Structures     50       Module M0878: Statica and Dynamics of Structures     53       Module M0878: Statica and Dynamics of Structures     53       Module M0878: Stati			
Module M2004: Sustainable Circular Economy         12           Module M157: Practical module 2 (dual study program, Master's degree)         15           Module M157: Practical module 3 (dual study program, Master's degree)         15           Specialization Coastal Engineering         19           Module M056: Construction Robotics         21           Module M056: Sustainable Circular Economy         26           Module M056: Sustainable Circular Economy         26           Module M056: Construction Robotics         23           Module M057: Building Materials and Building Preservation         26           Module M073: Design of Prestressed Structures and Concrete Bridges         38           Module M067: Soli Machanics and - Dynamics         30           Module M067: Under Engineering and Harbour Planning         37           Module M068: Undergrupt Engineering         33           Module M068: Harbour Engineering and Harbour Planning         37           Module M068: Harbour Engineering and Project Management         45           Module M068: States and Dynamics of Structures         50           Module M068: Marine Gestechnics         30           Module M068: Marine Gestechnics         53           Module M068: Marine Gestechnics         57           Module M068: Marine Gestechnics         57			
Module M175: Practical module 3 (dual study program, Master's degree)       17         Specialization Coastal Engineering       19         Module M0964: Underground Constructions       19         Module M0959: Geotechnics III       23         Module M1895: Digital Twinning in Civil Engineering       23         Module M1895: Digital Twinning in Civil Engineering       23         Module M0723: Design of Prestressed Structures and Concrete Bridges       30         Module M0825: Building Materials and Building Preservation       36         Module M0827: Modeling in Water Management       33         Module M0827: Modeling in Water Management       33         Module M0827: City Planning       42         Module M0827: City Planning       45         Module M0827: City Planning       45         Module M0839: Statics and Droject Management.       37         Module M0899: Statics and Droject Management.       47         Module M0899: Statics and Droject Management.       47 <td>Module M2004:</td> <td>Sustainable Circular Economy</td> <td></td>	Module M2004:	Sustainable Circular Economy	
Module M1758: Practical module 3 (dual study program, Master's degree)         11           Module M0699: Geotechnics II         19           Module M0699: Geotechnics II         19           Module M1748: Construction Robotics         21           Module M1748: Construction Robotics         23           Module M0593: Building Materials and Building Preservation         26           Module M0553: Digital Twining in Civil Engineering         28           Module M0525: Digital Twining in Civil Engineering         33           Module M0253: Distai Twining Water Management         33           Module M0282: Water Management         34           Module M0282: Tokeling in Water Management         45           Module M0222: City Planning         47           Module M0299: Statics and Dynamics of Structures         90           Module M0299: Statics and Dynamics of Structures         50           Module M0299: Statics and Dynamics of Structures         51           Module M0299: Statics and Dynamics of Structures         59           Module M0299: Statics and Dynamics of Structures         50           Module M0299: Statics and Dynamics of Structures         59           Module M0299: Statics and Dynamics of Structures         59           Module M0299: Statics and Dynamics of Structures         50           M			
Specialization Coastal Engineering       19         Module M0996: Geotechnics III       19         Module M1885: Digital Twinning in Civil Engineering       23         Module M1885: Digital Twinning in Civil Engineering       23         Module M0233: Building Materials and Building Preservation       26         Module M0233: Building Materials and Building Preservation       26         Module M0253: Urban Environmental Management       33         Module M0252: Irban Environmental Management       33         Module M0323: Urban Environmental Management       35         Module M0323: Urban Environmental Management       35         Module M0321: Stocka and Project Management       45         Module M0322: City Planning       45         Module M0323: Statics and Droject Management       47         Module M0393: Statics and Droject Management       47         Module M1721: Water and Environment: Theory and Application       56         Module M1323: Port Logistics       57         Module M1321: Water and Environment: Theory and Application       56         Module M1224: Smart Monitoring       63         Module M1232: Mattine Arasport       61         Module M1243: Thin-wailed Structures       77         Module M0353: Steal and Composite Structures       77         M	Module M1757:	Practical module 2 (dual study program, Master's degree)	
Module M0699: Geotechnics III         19           Module M0644: Underground Constructions         21           Module M1748: Construction Robotics         23           Module M0593: Building Materials and Building Preservation         26           Module M0756: Soil Mechanics and -Dynamics         30           Module M0756: Soil Mechanics and -Dynamics         30           Module M0282: Urban Environmental Management         33           Module M0282: Urban Environmental Management         33           Module M0282: Urban Environmental Management         33           Module M0282: City Planning         39           Module M0292: City Planning         42           Module M0399: Stele Construction Project Management         47           Module M0399: Stele Construction Project Management         33           Module M0399: Stele Construction Project Management         33           Module M0399: Stele Construction Project Management         47           Module M1313: Port Logistics         57           Module M0363: Marine Geotechnics         59           Module M0363: Marine Geotechnics         59           Module M1313: Port Logistics         57           Module M132: Maritime Transport         61           Module M132: Maritime Transport         61           Module M1			1
Module M0964: Underground Constructions         21           Module M1488: Construction Robotics         23           Module M0723: Design of Prestressed Structures and Concrete Bridges         26           Module M0825: Solit McEntaries and Building Preservation         26           Module M0825: Solit McEntaries and Summis         30           Module M0825: Modeling in Water Management         33           Module M0825: Modeling in Water Management         33           Module M0825: Modeling of Hydraulic Engineering         39           Module M0825: Modeling of Hydraulic Engineering         42           Module M0827: Construction Logistics and Project Management         47           Module M0829: Statics and Dynamics of Structures         50           Module M133: Port Logistics         57           Module M133: Rort Logistics         57           Module M133: Rort Logistics         59           Module M133: Rort Logistics         57           Module M133: Not Logistics         57           Module M133: Not Logistics         57           Module M133: Instructuring         63			
Module M1748; Construction Robotics         23           Module M0593; Building Materials and Building Preservation         26           Module M0752; Design of Prestressed Structures and Concrete Bridges         28           Module M0756; Soil Machanics and -Dynamics         30           Module M0275; Noteling in Water Management         33           Module M0828; Urban Environmental Management         33           Module M0824; Water Management         34           Module M0824; Water Management         35           Module M0824; Water Management         37           Module M0824; Water Management         42           Module M0824; Water Management         47           Module M0939; Statics and Dynamics of Structures         50           Module M0939; Statics and Dynamics of Structures         53           Module M133; Port Logistics         54           Module M133; Port Logistics         57           Module M1325; Thin waller and Environment: Theory and Application         63           Module M1325; Scatal Hydraulic Engineering 1         68           Module M1328; Sustainable energy from wind and water         65           Module M1328; Sustainable energy from wind and water         65           Module M1328; Sustainable on d'Application Panages         72           Module M053; Water Protection <td></td> <td></td> <td></td>			
Module M053: Building Materials and Building Preservation         26           Module M0735: Soil Mechanics and -Dynamics         30           Module M0235: Urban Environmental Management         33           Module M0828: Urban Environmental Management         35           Module M0821: Modeling of Hydraulic Engineering         37           Module M0822: City Panning         42           Module M0822: City Panning         45           Module M0822: City Panning         45           Module M0831: Materials and Project Management         47           Module M0895: Status and Dynamics of Structures         50           Module M0999: Steel Construction Project         53           Module M0398: Status and Dynamics of Structures         59           Module M1721: Water and Environment: Theory and Application         61           Module M1722: Water and Environment: Theory and Application         61           Module M1723: Watter and Environment: Theory and Application         63           Module M1743: Strait Monitoring         63           Module M058: Coastal Hydraulic Engineering 1         68           Module M0595: Examination of Materials, Structural Condition and Damages         72           Module M0595: Streat Hydraulic Engineering 1         68           Module M0595: Streat Hydraulic Engineering 1         79			
Module M0723: Design of Prestressed Structures and Concrete Bridges         28           Module M0827: Modeling in Water Management         33           Module M0827: Modeling in Water Management         35           Module M0828: Urban Environmental Management         35           Module M0820: Harbour Engineering and Harbour Planning         37           Module M0874: Wastewater Systems         39           Module M0874: Wastewater Systems         39           Module M0895: Statics and Dynamics of Structures         50           Module M0895: Statics and Dynamics of Structures         50           Module M0895: Statics and Dynamics of Structures         50           Module M1233: Port Logistics         57           Module M133: Port Logistics         57           Module M133: Port Logistics         57           Module M1324: Structures         59           Module M1324: Structures         59           Module M1353: Port Logistics         57           Module M1324: Structures         59           Module M1332: Narine Geotechnics         59           Module M1332: Nort Logistics         57           Module M1332: Marine Transport         61           Module M1332: Marine Transport         63           Module M0551: Water Protection         75	Module M1895:	Digital Twinning in Civil Engineering	25
Module M0756: Soil Mechanics and -Dynamics         30           Module M0828: Urban Environmental Management         35           Module M0828: Urban Environmental Management         35           Module M086: Harbour Engineering and Harbour Planning         37           Module M081: Modelling of Hydraulic Engineering         42           Module M093: Statics and Project Management         47           Module M093: Statics and Dynamics of Structures         50           Module M093: Statics and Dynamics of Structures         50           Module M093: Statics and Project Management         47           Module M093: Statics and Dynamics of Structures         53           Module M033: Statics and Dynamics of Structures         53           Module M1721: Watter and Environment: Theory and Application         56           Module M173: Statianbits energy from wind and water         63           Module M173: Sustainable energy from wind and water         65           Module M058: Coastal Hydraulic Engineering I         68           Module M059: Examination of Materials, Structural Condition and Damages         72           Module M059: Exel and Composite Structures         73           Module M059: Stel and Composite Structures         75           Module M059: Stel and Composite Structures         77           Module M059: Stel and Composite S			
Module W0827: Modeling in Water Management         33           Module W0860: Harbour Engineering and Harbour Planning         37           Module W0860: Harbour Engineering and Harbour Planning         37           Module M0861: Modeling of Hydraulic Engineering         42           Module M0871: Wastewater Systems         42           Module M0977: Construction Logistics and Project Management         47           Module M098: Statics and Dynamics of Structures         50           Module M0599: Steel Construction Project         53           Module M053: Marine Geotechnics         54           Module M133: Port Logistics         57           Module M134: Thin-walled structures         59           Module M134: Structures         59           Module M134: Structures         63           Module M134: Structures         59           Module M134: Structures         63           Module M134: Structures         63           Module M134: Structures         70           Module M059: Examination of Materials, Structural Condition and Damages         72           Module M059: Steal and Composite Structures         73           Module M059: Steal and Composite Structures         77           Module M059: Steal and Composite Structures         77           Module M059: Steal a			
Module W0828: Urban Environmental Management         35           Module W0861: Matour Engineering and Harbour Planning         39           Module W0861: Modelling of Hydraulic Engineering         42           Module W0922: City Planning         45           Module W0923: City Planning         45           Module W0924: City Planning         45           Module W0925: Statics and Dynamics of Structures         50           Module M0929: State Construction Project         53           Module M1721: Water and Environment: Theory and Application         56           Module M133: Port Logistics         57           Module M133: Port Logistics         57           Module M132: Maritime Transport         61           Module M132: Maritime Transport         61           Module M058: Coastal Hydraulic Engineering 1         68           Module M058: Coastal Hydraulic Engineering 1         68           Module M058: Statinable energy from wind and water         65           Module M058: Coastal Hydraulic Engineering         72           Module M058: Statinable energy from wind and water         65           Module M058: Stating and on of Materials, Structural Condition and Damages         72           Module M059: Stating and thydraulic Engineering         73           Module M059: Stating and thysis tractural s			
Module M0860: Harbour Engineering and Harbour Planning         37           Module M0874: Wastewater Systems         42           Module M0874: Wastewater Systems         42           Module M0974: Construction Logistics and Project Management         47           Module M0987: Statics and Dynamics of Structures         50           Module M0989: Statel Construction Project         53           Module M1312: Water and Environment: Theory and Application         56           Module M1132: Martime Geotechnics         57           Module M1132: Martime Transport         61           Module M1742: Smart Monitoring         63           Module M1785: Sustainable energy from wind and water         65           Module M1785: Sustainable energy from wind and water         65           Module M1785: Sustainable energy from wind and water         68           Module M0785: Examination of Materials, Structural Condition and Damages         72           Module M0793: Concrete Structures         73           Module M0963: Steel and Composite Structures         77           Module M0963: Steel and Composite Structures         73           Module M0963: Steel and Composite Structures         73           Module M0963: Steel and Composite Structures         77           Module M0963: Steel and Composite Structures         79			
Module M0274: Wastewater Systems       42         Module M0222: City Planning       45         Module M0398: Statics and Dynamics of Structures       50         Module M0398: Statics and Dynamics of Structures       50         Module M0598: Statics and Dynamics of Structures       50         Module M132: Marine Geotechnics       54         Module M132: Narine Geotechnics       54         Module M132: Thin-walled structures       59         Module M132: Sustainable energy from wind and water       63         Module M058: Coastal Hydraulic Engineering 1       68         Module M058: Water Protection       70         Module M059: Extructures Entructures       73         Module M059: Steat Coastal Hydraulic Engineering 1       68         Module M059: Steat and Composite Structures       73         Module M059: Steat and Composite Structures       73         Module M056: Steat and Composite Structures       74         Module M056: Steat and Composite Structures       75         Module M056: Stute and Composite Structures       74         Module M050: Water Resources and -Supply       86         Module M050: State and Composite Structures       75         Module M050: State and Compastie Structures       93         Module M050: Water Resources and -Supply			
Module M0922: City Planning45Module M0998: Statics and Dynamics of Structures50Module M0998: Statics and Dynamics of Structures50Module M0563: Marine Geotechnics54Module M1721: Water and Environment: Theory and Application56Module M1731: Water and Environment: Theory and Application56Module M183: Port Logistics57Module M183: Port Logistics57Module M183: Martine Transport61Module M183: Sustainable energy from wind and water63Module M183: Castal Hydraulic Engineering I68Module M183: Sustainable energy from wind and water67Module M058: Castal Hydraulic Engineering I68Module M059: Examination of Materials, Structural Condition and Damages72Module M059: Static Transportation Planning75Module M059: Stater Archaet Composite Structures77Module M059: Stater Archaet Costal Engineering79Module M059: Stater Archaet Costal Engineering79Module M059: Stater Archaet Costal Protection in a Changing Climate (SeaPlaC)91Module M059: Stater Archaet Costal Protection in CAmaging Climate (SeaPlaC)93Module M179: Sustainable Nature-based Costal Protection in Changing Climate (SeaPlaC)91Module M179: Sustainable Nature-based Costal Protection in Changing Climate (SeaPlaC)91Module M179: Sustainable Nature-based Costal Protection in Changing Climate (SeaPlaC)93Module M179: Sustainable Nature-based Costal Protection in Changing Climate (SeaPlaC)91Module M179: Sustainable Nature-based Costa			
Module M0977: Construction Logistics and Project Management     47       Module M0998: Statics and Dynamics of Structures     50       Module M0999: State Construction Project     53       Module M1212: Water and Environment: Theory and Application     56       Module M1132: Mort Logistics     57       Module M1132: Martime Environment: Theory and Application     56       Module M1132: Martime Transport     61       Module M1845: Thin-walled structures     59       Module M1845: Thin-walled structures     63       Module M1878: Sustainable energy from wind and water     65       Module M0581: Water Protection     70       Module M0581: Structures     73       Module M0581: Water Protection     70       Module M0581: Structures     73       Module M0581: Structures     73       Module M0581: Structures     73       Module M0581: Structures     77       Module M0581: Structures     77       Module M0581: Structures     77       Module M0581: Structures and Coastal Engineering     78       Module M051: Stady and Composite Structures     77       Module M051: Stady and Coastal Engineering     96       Module M155: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)     89       Module M155: Scientift Cowrking in Computational Engineering     95       Module M			
Module M0998: Statics and Dynamics of Structures         50           Module M063: Marine Geotechnics         53           Module M1721: Water and Environment: Theory and Application         56           Module M133: Port Logistics         57           Module M133: Port Logistics         57           Module M1731: Martime Transport         61           Module M1741: Sustainable energy from wind and water         65           Module M0588: Coastal Hydraulic Engineering I         68           Module M0595: Examinable energy from wind and water         67           Module M0595: Examinable energy from wind and water         72           Module M0595: Examinable energy from wind and water         73           Module M0595: Examinable energy from wind and water         73           Module M0595: Examinable metergy from wind and water         73           Module M0595: Examination of Materials, Structural Condition and Damages         72           Module M0595: Examination of Materials, Structures         77           Module M0595: Steal and Composite Structures         77           Module M0596: Selected Transportation Planning         79           Module M0597: Study Work Harbour and Coastal Engineering (AKWAS)         89           Module M0596: Selected Tones on Clupping         85           Module M1795: Sustainable Nature-based Coastal P	Module M0922:	City Planning	
Module M0999: Steel Construction Project     53       Module M0663: Marine Geotechnics     54       Module M1721: Water and Environment: Theory and Application     56       Module M133: Port Logistics     57       Module M134: Thin-walled structures     59       Module M132: Martime Transport     61       Module M1878: Sustainable energy from wind and water     63       Module M058: Coastal Hydraulic Engineering I     68       Module M058: Water Protection     70       Module M059: Examination of Materials, Structural Condition and Damages     72       Module M059: Steel and Composite Structures     73       Module M056: Selected Topics in Civil Engineering     79       Module M056: Selected Topics in Civil Engineering     79       Module M056: Selected Topics in Civil Engineering     79       Module M056: Selected Topics in Civil Engineering     86       Module M056: Selected Topics in Civil Engineering     86       Module M056: Selected Topics in Civil Engineering     86       Module M179: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)     91       Module M179: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)     91       Module M124: Modern discretization methods in structural mechanics     93       Module M124: Modern discretization taw     96       Module M124: Soastal Hydraulic Engineering I <td>Module M0977: Module M0998:</td> <td>Construction Logistics and Project Management Statics and Dynamics of Structures</td> <td></td>	Module M0977: Module M0998:	Construction Logistics and Project Management Statics and Dynamics of Structures	
Module M063: Marine Geotechnics54Module M1721: Water and Environment: Theory and Application56Module M133: Port Logistics57Module M133: Port Logistics59Module M133: Martime Transport61Module M1741: Sustainable energy from wind and water63Module M0581: Coastal Hydraulic Engineering I68Module M0595: Examination of Materials, Structural Condition and Damages72Module M0595: Elected Transportation Planning75Module M0595: Stevel and Composite Structures77Module M0595: Stevel and Composite Structures77Module M0597: Study Work Harbour and Coastal Engineering85Module M0597: Study Work Harbour and Coastal Protection in a Changing Climate (SeaPiaC)91Module M1595: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M0595: Coastal Hydraulic Engineering Intructural mechanics93Module M0595: Coastal Hydraulic Engineering I96Module M0595: Coastal Hydraulic Engineering II98Module M0595: Coastal Hydraulic Engineering II98Module M0595: Coastal Hydraulic Engineering II98Module M0595: Coastal Hydraulic Engineering102Module M0595: Coastal Hydraulic Engineering102 <td></td> <td></td> <td></td>			
Module M1133: Port Logistics     57       Module M1134: Thin-walled structures     59       Module M124: Thin-walled structures     61       Module M124: Smart Monitoring     63       Module M058: Coastal Hydraulic Engineering I     68       Module M059: Examination of Materials, Structural Condition and Damages     70       Module M0963: Steel and Composite Structures     73       Module M0963: Steel and Composite Structures     77       Module M0963: Steel and Composite Structures     77       Module M030: Work Harbour and Coastal Engineering     85       Module M031: Vater Resources and -Supply     86       Module M179: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)     91       Module M179: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)     91       Module M179: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)     91       Module M179: Sustainable Augina (Computational Engineering     95       Module M179: Sustainable Augina (Computational Engineering     96       Module M179: Sustainable Mydraulic Engineering II     98       Module M203: Biological Waste Treatment     100       Module M203: Biolog			
Module M1845: Thin-walled structures59Module M132: Maritime Transport61Module M1374: Smart Monitoring63Module M1878: Sustainable energy from wind and water65Module M0581: Water Protection68Module M0581: Water Protection70Module M0595: Examination of Materials, Structural Condition and Damages72Module M0593: Integrated Transportation Planning75Module M0923: Integrated Transportation Planning79Module M0936: Selected Topics in Civil Engineering79Module M0967: Study Work Harbour and Coastal Engineering85Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M1795: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)91Module M1795: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)91Module M1795: Sustainable Nature-topased Nature-topased Coastal Protection in a Changing Climate (SeaPiaC)91Module M1795: Suiding and Excavation Law96Module M0595: Coastal Hydraulic Engineering II98Module M0595: Coastal Hydraulic Engineering III98Module M	Module M1721:	Water and Environment: Theory and Application	56
Module M1132: Maritime Transport61Module M1724: Smart Monitoring63Module M1788: Sustainable energy from wind and water65Module M0858: Coastal Hydraullic Engineering I68Module M0595: Examination of Materials, Structural Condition and Damages72Module M0595: Examination of Materials, Structural Condition and Damages72Module M0593: Steel and Composite Structures73Module M0963: Steel and Composite Structures77Module M0963: Selected Topics in Civil Engineering79Module M0967: Study Work Harbour and Coastal Engineering85Module M0967: Study Work Harbour and Coastal Engineering (AKWAS)89Module M0967: Study Work Harbour and Coastal Engineering (AKWAS)89Module M1729: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)91Module M1729: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)91Module M1729: Scientific Working in Computational Engineering95Module M1725: Scientific Working in Computational Engineering95Module M1251: Finite element modeling of structures100Module M2033: Subsurface Processes104Module M2033: Subsurface Processes104Module M0544: Underground Constructions108Module M0545: Sinite element modeling of structures108Module M0545: Underground Constructions108Module M0545: Suburface Processes104Module M0545: Suburface Processes104Module M0545: Suburface Processes110Module M0545: Undergrou			
Module M1724: Smart Monitoring63Module M1878: Sustainable energy from wind and water65Module M0581: Coastal Hydraulic Engineering I68Module M0581: Water Protection70Module M0585: Examination of Materials, Structural Condition and Damages72Module M0923: Integrated Transportation Planning75Module M0923: Integrated Transportation Planning75Module M0963: Steel and Composite Structures77Module M0963: Steel and Composite Structures77Module M0963: Steel and Composite Structures77Module M0963: Steel and Composite Structures79Module M0801: Water Resources and -Supply86Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M1505: Jadaptation to Climate Change in Hydraulic Engineering (AKWAS)91Module M1505: Building and Excavation Law96Module M1255: Scientific Working in Computational Engineering95Module M2025: Finite element modeling of structures102Module M2025: Finite element modeling of structures102Module M2025: Finite element modeling of structures104Specialization Geotechnics III106Module M0699: Geotechnics III106Module M0699: Geotechnics III106Module M0699: Gotechnics and Duynamics113Module M0732: Disign of Prestressed Structures and Concrete Bridges115Module M0699: Gotechnics III122Module M0733: Digital Twinning in Civil Engineering124Module M0693: Building Materials and Building			
Module M1878: Sustainable energy from wind and water       65         Module M0858: Coastal Hydraulic Engineering I       68         Module M0595: Examination of Materials, Structural Condition and Damages       72         Module M0923: Integrated Transportation Planning       75         Module M0923: Steel and Composite Structures       77         Module M0963: Steel and Composite Structures       77         Module M0961: Water Resources and -Supply       86         Module M0801: Water Resources and -Supply       86         Module M1779: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)       91         Module M1742: Scientific Working in Computational Engineering       95         Module M059: Coastal Hydraulic Engineering II       98         Module M0203: Biological Waste Treatment       100         Module M0203: Subsurface Processes       104         Module M0203: Subsurface Processes       104         Module M0499: Geotechnica III       106         Module M0499			
Module M0858: Coastal Hydraulic Engineering I68Module M05581: Water Protection70Module M0559: Examination of Materials, Structural Condition and Damages72Module M0713: Concrete Structures73Module M0963: Steel and Composite Structures73Module M0963: Steel and Composite Structures77Module M0963: Steel and Composite Structures77Module M0967: Study Work Harbour and Coastal Engineering79Module M0967: Study Work Harbour and Coastal Engineering (AKWAS)86Module M0801: Water Resources and -Supply86Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M1779: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)91Module M1795: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)91Module M1956: Building and Excavation Law96Module M1955: Building and Excavation Law96Module M0859: Coastal Hydraulic Engineering II98Module M0203: Biological Waster Treatment100Module M0203: Biological Waster Treatment102Module M0699: Geotechnics III106Module M0699: Geotechnics III106Module M0593: Building Materials and Building Preservation113Module M0593: Building Materials and Building Preservation112Module M0593: Building Materials and Building Preservation113Module M0593: Building Materials and Propert Panning124Module M0853: Costal Hydraulic Engineering122Module M0853: Building of Hydraul			
Module M0581: Water Protection70Module M0595: Examination of Materials, Structural Condition and Damages72Module M0913: Concrete Structures73Module M0963: Steel and Composite Structures77Module M0963: Steel and Composite Structures77Module M0963: Steel and Composite Structures77Module M0965: Steel Cet Topics in Civil Engineering85Module M0967: Study Work Harbour and Coastal Engineering (AKWAS)86Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M1779: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)91Module M1725: Scientific Working in Computational Engineering95Module M1725: Scientific Working in Computational Engineering96Module M2003: Biological Waste Treatment100Module M2003: Biological Waste Treatment100Module M2033: Subsurface Processes104Specialization Geotechnical Engineering106Module M0694: Underground Constructions108Module M728: Digital Twinning in Civil Engineering110Module M748: Construction Robotics113Module M758: Soil Mechanics and -Dynamics117Module M0593: Building Materials and Building Preservation113Module M0593: Building Materials and Building Preservation113Module M0593: Building Materials and Building Preservation113Module M0593: Building Materials and Building Preservation113M			
Module M0713: Concrete Structures73Module M0923: Integrated Transportation Planning75Module M0963: Steel and Composite Structures77Module M0963: Steel and Composite Structures77Module M0963: Steel and Composite Structures77Module M0963: Steel and Composite Structures79Module M0967: Study Work Harbour and Coastal Engineering85Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M1844: Modern discretization methods in structural mechanics93Module M1725: Scientific Working in Computational Engineering95Module M059: Coastal Hydraulic Engineering II98Module M0659: Coastal Hydraulic Engineering II98Module M2033: Biological Waste Treatment100Module M2033: Subsurface Processes104Specialization Geotechnical Engineering106Module M0694: Underground Constructions108Module M0694: Sign of Prestressed Structures and Concrete Bridges113Module M0725: Design of Prestressed Structures and Concrete Bridges115Module M0593: Building Materials and Building Preservation113Module M0827: Modeling in Water Management122Module M0828: Urban Environmental Management122Module M0827: Modeling of Hydraulic Engineering124Module M0827: Wodeling of Hydraulic Engineering124Module M0827: Modeling of Hydraulic Engineering124Module M0827: Modeling of Hydraulic Engine			70
Module M0923: Integrated Transportation Planning75Module M0963: Stelet and Composite Structures77Module M0963: Steletad Topics in Civil Engineering79Module M0967: Study Work Harbour and Coastal Engineering (AKWAS)85Module M0801: Water Resources and -Supply86Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M1779: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)91Module M1844: Modern discretization methods in structural mechanics93Module M1755: Scientific Working in Computational Engineering95Module M1956: Building and Excavation Law96Module M2033: Biological Waste Treatment100Module M2033: Subsurface Processes102Module M2033: Subsurface Processes104Specialization Geotechnical Engineering106Module M0999: Geotechnics III106Module M1748: Construction Robotics110Module M0593: Building Materials and Building Preservation113Module M0543: Underground Constructions113Module M0543: Underground Constructures and Concrete Bridges115Module M0543: Urban Environmental Management120Module M0554: Urban Environmental Management120Module M0860: Harbour Engineering and Harbour Planning124Module M0861: Modelling of Hydraulic Engineering124Module M0861: Modelling of Hydraulic Engineering126Module M0861: Modelling of Hydraulic Engineering126Module M0861: Modelling of Hydraulic Engineering <t< td=""><td></td><td>· · · · · · · · · · · · · · · · · · ·</td><td></td></t<>		· · · · · · · · · · · · · · · · · · ·	
Module M0963: Steel and Composite Structures77Module M0963: Steelcted Topics in Civil Engineering79Module M0967: Study Work Harbour and Coastal Engineering85Module M0801: Water Resources and -Supply86Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M1505: Maptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M1779: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)91Module M1725: Scientific Working in Computational Engineering95Module M0859: Coastal Hydraulic Engineering II98Module M2003: Biological Waste Treatment100Module M2003: Biological Waste Treatment100Module M0699: Geotechnics III106Module M0699: Geotechnics III106Module M0964: Underground Constructions108Module M0965: Suilding and Excavation Law106Module M0969: Geotechnics III106Module M0969: Geotechnics III100Module M0699: Geotechnics III106Module M0723: Design of Prestressed Structures and Concrete Bridges113Module M0732: Design of Prestressed Structures and Concrete Bridges115Module M0860: Harbour Engineering and Harbour Planning124Module M0861: Modelling of Hydraulic Engineering126Module M0873: Modeling in Water Management120Module M0861: Modelling of Hydraulic Engineering126Module M0873: Modeling of Hydraulic Engineering124Module M0861: Modelling of Hydraulic Engineering124			
Module M0969: Selected Topics in Civil Engineering79Module M0967: Study Work Harbour and Coastal Engineering85Module M0801: Water Resources and -Supply86Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M1779: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)91Module M1775: Scientific Working in Computational Engineering93Module M1725: Scientific Working in Computational Engineering95Module M059: Coastal Hydraulic Engineering II98Module M2003: Biological Waste Treatment100Module M2003: Suburface Processes102Module M0699: Geotechnical Engineering106Module M0699: Geotechnics III106Module M1785: Digital Twinning in Civil Engineering106Module M1785: Digital Twinning in Civil Engineering112Module M0599: Building Anterials and Building Preservation113Module M0595: Digital Twinning in Civil Engineering112Module M0595: Building in Water Management120Module M0572: Design of Prestressed Structures and Concrete Bridges115Module M0860: Harbour Engineering Marken120Module M0861: Modeling of Hydraulic Engineering124Module M0861: Modeling of Hydraulic Engineering124Module M0861: Modeling in Water Management120Module M0861: Modeling of Hydraulic Engineering124Module M0861: Modeling of Hydraulic Engineering126Module M0861: Modeling of Hydraulic Engineering132Module M0874: Wastewater Systems<			
Module M0967: Study Work Harbour and Coastal Engineering85Module M0801: Water Resources and -Supply86Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M1779: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)91Module M1779: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)93Module M1725: Scientific Working in Computational Engineering95Module M1956: Building and Excavation Law96Module M0859: Coastal Hydraulic Engineering II98Module M2003: Biological Waste Treatment100Module M2033: Subsurface Processes104Specialization Geotechnical Engineering106Module M0694: Underground Constructions108Module M0694: Underground Constructions108Module M073: Design of Prestressed Structures and Concrete Bridges115Module M073: Design of Prestressed Structures and Concrete Bridges117Module M0827: Modeling in Water Management122Module M0828: Urban Environmental Management122Module M0841: Modelling of Hydraulic Engineering124Module M0842: Undeling in Water Management122Module M0841: Modelling of Hydraulic Engineering124Module M0828: Urban Environmental Management122Module M0841: Modelling of Hydraulic Engineering124Module M0842: City Planning124Module M0842: Undeiling of Hydraulic Engineering126Module M0843: Wote and Project Management132Module M0874: Wastewater Systems <td></td> <td></td> <td></td>			
Module M0801: Water Resources and -Supply86Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)89Module M1779: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)91Module M1844: Modern discretization methods in structural mechanics93Module M1725: Scientific Working in Computational Engineering95Module M0859: Coastal Hydraulic Engineering II98Module M0859: Coastal Hydraulic Engineering II98Module M2003: Biological Waste Treatment100Module M2033: Subsurface Processes102Module M0699: Geotechnical Engineering106Module M0699: Geotechnical III106Module M0699: Geotechnical III106Module M0593: Building Materials and Building Preservation113Module M0753: Design of Prestressed Structures and Concrete Bridges115Module M0755: Soil Mechanics and -Dynamics122Module M0827: Modeling in Water Management120Module M0841: Wastewater Systems122Module M0842: Urban Environmental Management120Module M0842: Urban Environmental Management122Module M0842: Wastewater Systems129Module M0842: Wastewater Systems129Module M0842: Uty Planning132Module M0842: Wodeling of Hydraulic Engineering132Module M0842: Wodeling of Hydraulic Engineering126Module M0842: Wodeling of Hydraulic Engineering126Module M0842: Wastewater Systems129Module M0844: Wastewater Systems129Module			
Module M1779: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)91Module M1844: Modern discretization methods in structural mechanics93Module M1725: Scientific Working in Computational Engineering95Module M1956: Building and Excavation Law96Module M2059: Coastal Hydraulic Engineering II98Module M2025: Finite element modeling of structures100Module M2033: Subsurface Processes104Specialization Geotechnical Engineering106Module M0699: Geotechnical Engineering106Module M1748: Construction Robotics110Module M1895: Digital Twinning in Civil Engineering112Module M0593: Building Materials and Building Preservation113Module M0756: Soil Mechanics and -Dynamics117Module M0827: Modeling in Water Management122Module M0861: Modeling of Hydraulic Engineering124Module M0861: Modeling of Hydraulic Engineering124Module M0822: City Planning126Module M0861: Modeling of Hydraulic Engineering126Module M0877: Construction Logistics and Project Management132Module M0972: City Planning132Module M0977: Construction Logistics and Project Management134Module M0975: Steel Construction Project140Module M0663: Marine Geotechnics141	Module M0801:	Water Resources and -Supply	
Module M1844: Modern discretization methods in structural mechanics93Module M1725: Scientific Working in Computational Engineering95Module M1956: Building and Excavation Law96Module M0859: Coastal Hydraulic Engineering II98Module M2003: Biological Waste Treatment100Module M2033: Subsurface Processes102Module M2033: Subsurface Processes104Specialization Geotechnical Engineering106Module M0699: Geotechnics III106Module M0699: Geotechnics III106Module M1748: Construction Robotics110Module M0595: Digital Twinning in Civil Engineering112Module M0595: Boilding Materials and Building Preservation113Module M0723: Design of Prestressed Structures and Concrete Bridges117Module M0827: Modeling in Water Management120Module M0828: Urban Environmental Management122Module M0828: Urban Environmental Management122Module M0828: Urban Environmental Management122Module M0829: City Planning124Module M0821: Modelling of Hydraulic Engineering126Module M0821: Modelling of Hydraulic Engineering126Module M0827: Notelling of Hydraulic Engineering128Module M0829: City Planning124Module M0829: City Planning132Module M0829: City Planning134Module M0971: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M0998: Statics and Project Management134 <td></td> <td></td> <td></td>			
Module M1725: Scientific Working in Computational Engineering95Module M1956: Building and Excavation Law96Module M0859: Coastal Hydraulic Engineering II98Module M2003: Biological Waste Treatment100Module M2025: Finite element modeling of structures102Module M2033: Subsurface Processes104Specialization Geotechnical Engineering106Module M0699: Geotechnical Engineering106Module M0699: Geotechnics III106Module M1748: Construction Robotics110Module M1748: Construction Robotics110Module M0730: Bigital Twinning in Civil Engineering112Module M0730: Boign of Prestressed Structures and Concrete Bridges115Module M0730: Boign of Prestressed Structures and Concrete Bridges117Module M0827: Modeling in Water Management122Module M0861: Modelling of Hydraulic Engineering124Module M0861: Modelling of Hydraulic Engineering124Module M0861: Modelling of Hydraulic Engineering126Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0972: City Planning132Module M0972: City Planning132Module M0972: City Planning132Module M0973: Stele Construction Logistics and Project Management134Module M0975: Stele Construction Project137Module M0975: Stele Construction Project134Module M0998: Statics and Dynamics of Structures137Module M0998: Stele Construction Project14			
Module M1956: Building and Excavation Law96Module M0859: Coastal Hydraulic Engineering II98Module M2003: Biological Waste Treatment100Module M2025: Finite element modeling of structures102Module M2033: Subsurface Processes104Specialization Geotechnical Engineering106Module M0699: Geotechnics III106Module M0964: Underground Constructions108Module M1748: Construction Robotics110Module M1795: Digital Twinning in Civil Engineering112Module M0593: Building Materials and Building Preservation113Module M0723: Design of Prestressed Structures and Concrete Bridges115Module M0756: Soil Mechanics and -Dynamics117Module M0827: Modeling in Water Management122Module M0860: Harbour Engineering and Harbour Planning124Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0922: City Planning132Module M0923: Stel Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M0998: Stel Construction Logistics and Project Management134Module M0998: Stel Construction Project140Module M0663: Marine Geotechnics141			
Module M0859: Coastal Hydraulic Engineering II98Module M2003: Biological Waste Treatment100Module M2025: Finite element modeling of structures102Module M2033: Subsurface Processes104Specialization Geotechnical Engineering106Module M0699: Geotechnics III106Module M1748: Construction Robotics110Module M1748: Construction Robotics110Module M0593: Building Materials and Building Preservation113Module M0593: Building Materials and Building Preservation113Module M0723: Design of Prestressed Structures and Concrete Bridges117Module M0827: Modeling in Water Management120Module M0860: Harbour Engineering124Module M0861: Modelling of Hydraulic Engineering124Module M0861: Modelling of Hydraulic Engineering124Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0922: City Planning132Module M0993: Statics and Dynamics of Structures137Module M0998: Statics and Dynamics of Structures137Module M0998: Statics and Dynamics of Structures137Module M0998: Statics and Dynamics of Structures134Module M0998: Statics and Dynamics of Structures137Module M0663: Marine Geotechnics141			
Module M2003: Biological Waste Treatment100Module M2025: Finite element modeling of structures102Module M2033: Subsurface Processes104Specialization Geotechnical Engineering106Module M0699: Geotechnical Engineering106Module M0964: Underground Constructions108Module M1748: Construction Robotics110Module M1748: Construction Robotics110Module M0593: Building Materials and Building Preservation113Module M0723: Design of Prestressed Structures and Concrete Bridges115Module M0827: Modeling in Water Management122Module M0828: Urban Environmental Management122Module M0860: Harbour Engineering and Harbour Planning124Module M0874: Wastewater Systems129Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M0999: Steel Construction Logistics and Project Management134Module M0999: Steel Construction Project141			
Module M2033: Subsurface Processes104Specialization Geotechnical Engineering106Module M0699: Geotechnics III106Module M0964: Underground Constructions108Module M1748: Construction Robotics110Module M1748: Digital Twinning in Civil Engineering112Module M0593: Building Materials and Building Preservation113Module M0723: Design of Prestressed Structures and Concrete Bridges117Module M0756: Soil Mechanics and -Dynamics117Module M0827: Modeling in Water Management120Module M0828: Urban Environmental Management122Module M0860: Harbour Engineering and Harbour Planning124Module M0874: Wastewater Systems129Module M0972: City Planning132Module M0974: Wastewater Systems129Module M0979: Statics and Dynamics of Structures137Module M0999: Steel Construction Project140Module M0999: Steel Construction Project140Module M0663: Marine Geotechnics141			
Specialization Geotechnical Engineering106Module M0699: Geotechnics III106Module M0964: Underground Constructions108Module M1748: Construction Robotics110Module M1895: Digital Twinning in Civil Engineering112Module M0593: Building Materials and Building Preservation113Module M0723: Design of Prestressed Structures and Concrete Bridges115Module M0756: Soil Mechanics and -Dynamics117Module M0827: Modeling in Water Management120Module M0828: Urban Environmental Management122Module M0860: Harbour Engineering and Harbour Planning124Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0972: City Planning132Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M09999: Steel Construction Project140Module M09999: Steel Construction Project141			102
Module M0699: Geotechnics III106Module M0964: Underground Constructions108Module M1748: Construction Robotics110Module M1748: Construction Robotics110Module M1895: Digital Twinning in Civil Engineering112Module M0593: Building Materials and Building Preservation113Module M0723: Design of Prestressed Structures and Concrete Bridges115Module M0756: Soil Mechanics and -Dynamics117Module M0827: Modeling in Water Management120Module M0828: Urban Environmental Management122Module M0860: Harbour Engineering and Harbour Planning124Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M0999: Steel Construction Project140Module M09663: Marine Geotechnics141			
Module M0964: Underground Constructions108Module M1748: Construction Robotics110Module M1895: Digital Twinning in Civil Engineering112Module M0593: Building Materials and Building Preservation113Module M0723: Design of Prestressed Structures and Concrete Bridges115Module M0756: Soil Mechanics and -Dynamics117Module M0827: Modeling in Water Management120Module M0828: Urban Environmental Management122Module M0860: Harbour Engineering and Harbour Planning124Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M0999: Steel Construction Project140Module M0663: Marine Geotechnics141			
Module M1748: Construction Robotics110Module M1895: Digital Twinning in Civil Engineering112Module M0593: Building Materials and Building Preservation113Module M0723: Design of Prestressed Structures and Concrete Bridges115Module M0756: Soil Mechanics and -Dynamics117Module M0827: Modeling in Water Management120Module M0828: Urban Environmental Management122Module M0860: Harbour Engineering and Harbour Planning124Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M0999: Steel Construction Project140Module M0663: Marine Geotechnics141			
Module M1895: Digital Twinning in Civil Engineering112Module M0593: Building Materials and Building Preservation113Module M0723: Design of Prestressed Structures and Concrete Bridges115Module M0756: Soil Mechanics and -Dynamics117Module M0827: Modeling in Water Management120Module M0828: Urban Environmental Management122Module M0860: Harbour Engineering and Harbour Planning124Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M0999: Steel Construction Project140Module M0663: Marine Geotechnics141			
Module M0593: Building Materials and Building Preservation113Module M0723: Design of Prestressed Structures and Concrete Bridges115Module M0756: Soil Mechanics and -Dynamics117Module M0827: Modeling in Water Management120Module M0828: Urban Environmental Management122Module M0860: Harbour Engineering and Harbour Planning124Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0922: City Planning132Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M0999: Steel Construction Project140Module M0663: Marine Geotechnics141			
Module M0756: Soil Mechanics and -Dynamics117Module M0827: Modeling in Water Management120Module M0828: Urban Environmental Management122Module M0860: Harbour Engineering and Harbour Planning124Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0922: City Planning132Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M0999: Steel Construction Project140Module M0663: Marine Geotechnics141		Puilding Materials and Puilding Procentation	113
Module M0827: Modeling in Water Management120Module M0828: Urban Environmental Management122Module M0860: Harbour Engineering and Harbour Planning124Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0922: City Planning132Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M0999: Steel Construction Project140Module M0663: Marine Geotechnics141		• • • • • • • • • • • • • • • • •	
Module M0828: Urban Environmental Management122Module M0860: Harbour Engineering and Harbour Planning124Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0922: City Planning132Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M09999: Steel Construction Project140Module M0663: Marine Geotechnics141			
Module M0860: Harbour Engineering and Harbour Planning124Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0922: City Planning132Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M09999: Steel Construction Project140Module M0663: Marine Geotechnics141			
Module M0861: Modelling of Hydraulic Engineering126Module M0874: Wastewater Systems129Module M0922: City Planning132Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M09999: Steel Construction Project140Module M0663: Marine Geotechnics141			
Module M0874: Wastewater Systems129Module M0922: City Planning132Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M0999: Steel Construction Project140Module M0663: Marine Geotechnics141		Modelling of Hydraulic Engineering	
Module M0977: Construction Logistics and Project Management134Module M0998: Statics and Dynamics of Structures137Module M0999: Steel Construction Project140Module M0663: Marine Geotechnics141			
Module M0998: Statics and Dynamics of Structures137Module M0999: Steel Construction Project140Module M0663: Marine Geotechnics141			
Module M0999: Steel Construction Project140Module M0663: Marine Geotechnics141			
Module M0663: Marine Geotechnics 141			
			1

Module M1845: Thin-walled structures	145
Module M1878: Sustainable energy from wind and water	147
Module M0858: Coastal Hydraulic Engineering I	150
Module M0581: Water Protection	152
Module M0595: Examination of Materials, Structural Condition and Damages	154
Module M0713: Concrete Structures	155
Module M0801: Water Resources and -Supply	157
Module M0923: Integrated Transportation Planning	160
Module M0963: Steel and Composite Structures	162
Module M0966: Study Work Foundation Engineering	164
Module M0969: Selected Topics in Civil Engineering	165
Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)	171
Module M1779: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)	173
Module M1725: Scientific Working in Computational Engineering	175
Module M1844: Modern discretization methods in structural mechanics	176
Module M1956: Building and Excavation Law	178
Module M0859: Coastal Hydraulic Engineering II	180
Module M2003: Biological Waste Treatment	182
Module M2025: Finite element modeling of structures	184
Module M2033: Subsurface Processes	186
Specialization Structural Engineering	188
Module M0713: Concrete Structures	188
Module M0699: Geotechnics III	190
Module M0963: Steel and Composite Structures	192
Module M1748: Construction Robotics	194
Module M1895: Digital Twinning in Civil Engineering	196
Module M0723: Design of Prestressed Structures and Concrete Bridges	197
Module M0756: Soil Mechanics and -Dynamics	199
Module M0827: Modeling in Water Management	202
Module M0828: Urban Environmental Management	204
Module M0860: Harbour Engineering and Harbour Planning	206
Module M0861: Modelling of Hydraulic Engineering	208
Module M0874: Wastewater Systems	211
Module M0922: City Planning	214
Module M0977: Construction Logistics and Project Management	216
Module M0998: Statics and Dynamics of Structures	219
Module M0593: Building Materials and Building Preservation	222
Module M0999: Steel Construction Project	224
Module M0663: Marine Geotechnics	225
Module M1724: Smart Monitoring	227
Module M1878: Sustainable energy from wind and water	229
Module M0858: Coastal Hydraulic Engineering I	232
Module M1845: Thin-walled structures	234
Module M0581: Water Protection	236
Module M0595: Examination of Materials, Structural Condition and Damages	238
Module M1345: Metallic and Hybrid Light-weight Materials	239
Module M0603: Nonlinear Structural Analysis	242
Module M0801: Water Resources and -Supply	244
Module M0923: Integrated Transportation Planning	247
Module M0964: Underground Constructions	240
Module M0965: Study Work Structural Engineering	251
Module M0969: Selected Topics in Civil Engineering	252
Module M1779: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)	
Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)	260
Module M1844: Modern discretization methods in structural mechanics	
Module M1725: Scientific Working in Computational Engineering	26/
Module M1956: Building and Excavation Law	265
Module M0859: Coastal Hydraulic Engineering II	
Module M2003: Biological Waste Treatment	269
Module M2025: Finite element modeling of structures	271
Module M2033: Subsurface Processes	273
Createlization Computational Engine onion	275
Madula M0062: Steal and Composite Structures	275
	277
Module M0699: Geotechnics III Module M0713: Concrete Structures	279
Madula M1749, Construction Debatics	201
Module M1748. Construction Robotics Module M2033: Subsurface Processes	283
Module M1845: Thin-walled structures	285
Module M1845. Thirlwalled Structures Module M0861: Modelling of Hydraulic Engineering	
Module M0801. Modeling of Hydraulic Engineering Module M1895: Digital Twinning in Civil Engineering	287
Madula M0000, Chaol Construction Dusiant	290
Madula M0662, Marina Coatachnics	202
Module M0005. Marine Geolechnics	
Madula MOCOE. Computational Chrystophica	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Module M0605: Computational Structural Dynamics Module M0606: Numerical Algorithms in Structural Mechanics	294 296

Module M0998: Statics and Dynamics of Structures	300
Module M0998. Status and Dynamics of Structures Module M0827: Modeling in Water Management	303
Module M0027: Modeling in Water Management	305
Module M0723: Design of Prestressed Structures and Concrete Bridges	307
Module M0725: Design of restressed structures and concrete bridges	309
Module M0750: Son Mechanics and Dynamics Module M0854: Mathematics IV	312
Module M0034: Mathematics IV Module M2032: Advanced Vadose Zone Hydrology	315
Module M2052: Advanced Vadose 201e Hydrology Module M0603: Nonlinear Structural Analysis	317
Module M0003: Nonlinear Structural Analysis Module M0964: Underground Constructions	319
Module M0304: Onderground Constructions Module M1725: Scientific Working in Computational Engineering	321
Module M1723. Scientific Working in Computational Engineering Module M1844: Modern discretization methods in structural mechanics	322
Module M1944. Modern discretization methods in structural methods. Module M1906: Study work computational engineering	324
Module M1900: Stady work computational engineering Module M0969: Selected Topics in Civil Engineering	325
Module M0909. Selected Topics in Civil Engineering Module M1956: Building and Excavation Law	331
Module M1950: Building and Excavation Law Module M2025: Finite element modeling of structures	333
Specialization Water and Traffic	335
Module M0964: Underground Constructions	335
Module M0595: Examination of Materials, Structural Condition and Damages	337
Module M0923: Integrated Transportation Planning	338
Module M0801: Water Resources and -Supply	340
Module M1748: Construction Robotics	343
Module M1974: Environmental microbiology and analytics	345
Module M0874: Wastewater Systems	348
Module M0828: Urban Environmental Management	351
Module M0875: Nexus Engineering - Water, Soil, Food and Energy	353
Module M0922: City Planning	355
Module M0977: Construction Logistics and Project Management	357
Module M0593: Building Materials and Building Preservation	360
Module M0998: Statics and Dynamics of Structures	362
Module M0982: Transportation Modelling	365
Module M0827: Modeling in Water Management	366
Module M0870: Management of Surface Water	368
Module M0860: Harbour Engineering and Harbour Planning	371
Module M1721: Water and Environment: Theory and Application	373
Module M1724: Smart Monitoring	374
Module M2002: Waste and Resource Management	376
Module M0871: Hydrological Systems	378
Module M2032: Advanced Vadose Zone Hydrology	380
Module M0949: Rural Development and Resources Oriented Sanitation for different Climate Zones	382
Module M0822: Process Modeling in Water Technology	384
Module M0713: Concrete Structures	387
Module M0963: Steel and Composite Structures	389
Module M0699: Geotechnics III	391
Module M1401: Study work Water and Traffic	393
Module M0802: Membrane Technology	394
Module M0581: Water Protection	396
Module M1720: Emerging Trends in Environmental Engineering	398
Module M1505: Adaptation to Climate Change in Hydraulic Engineering (AKWAS)	401
Module M1725: Scientific Working in Computational Engineering	400
Module M0969: Selected Topics in Civil Engineering	404
Module M1779: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)	410
Module M1956: Building and Excavation Law	412
Module M2003: Biological Waste Treatment	414
Module M2006: Waste Treatment and Recycling	416
Module M2033: Subsurface Processes	418
Thesis	420
Module M1801: Master thesis (dual study program)	420

### Program description

#### Content

Civil engineering deals with the erection of buildings of all kind, in particular of structures like bridges and tunnels, structures in hydraulic engineering, water supply, waste and waste water disposal, harbour construction, streets, hall construction, as well as industrial and housing construction, including refurbishment. The master program civil engineering gives graduates the qualification to process difficult projects in the construction practice, including the necessary competences in business and management. Buildings arise by the cooperation of owners, planning offices, contractors, environment, politicians and society. Civil engineering is located in the field between technical and economic constraint, political will and legal conditions. The master program prepares for that. The master program also opens the way to doctoral studies and successful research activities, assuming a sufficient diploma.

The master program civil engineering is associated with the bachelor program "Bau- und Umweltingenieurwesen" and "Allgemeine Ingenieurwissenschaften Vertiefung Bauingenieurwesen" of the University of Technology Hamburg in the sense of a consecutive course of studies. Possible entries from other bachelor programs are based on a catalog of requirements, described in the document "Specific Requirements for the Master Program Civil Engineering".

In addition to the foundational curriculum taught at TUHH, seminars on developing personal skills are integrated into the dual study programme, in the context of transfer between theory and practice. These seminars correspond to the modern professional requirements expected of an engineer, as well as promoting the link between the two places of learning.

The intensive dual courses at TUHH integrating practical experience consist of an academic-oriented and a practice-oriented element, which are completed at two places of learning. The academic-oriented element comprises study at TUHH. The practice-oriented element is coordinated with the study programme in terms of content and time, and consists of practical modules and phases spent in an affiliate company during periods when there are no lectures.

#### **Career prospects**

The graduates of the master program civil engineering are prepared for a leading professional activity in planning offices, at building contractors, building authorities, owners of major immovables and infrastructure, producers of building products, material testing institutions and in research facilities. It aims at activities in extensive and difficult projects, or in research and development. In Germany a great demand exists at this time for civil engineers in particular with good knowledge in structural engineering. The master program is based on this demand.

In addition, students acquire basic professional and personal skills as part of the dual study programme that enable them to enter professional practice at an early stage and to go on to further study. Students also gain practical work experience through the integrated practical modules. Graduates of the dual course have broad foundational knowledge, fundamental skills for academic work and relevant personal competences.

#### Learning target

The graduates of the master program civil engineering gain the specialist knowledge and the methods, to plan and erect new buildings, in particular concrete structures, steel structures, structures in water engineering, in foundation engineering, in water supply, waste and waste water disposal, including refurbishment of existing structures. This incorporates the realization of necessary preliminary investigations, the design of structural elements, the development of all necessary proofs and the project management.

The graduates of the master program are able to transfer the acquired knowledge in engineering, mathematics and natural sciences to practical applications and to analyze and solve problems on a scientific basis, even if these are unusual or incompletely defined and comprise complex specifications. The graduates are able to successfully work on research projects in the field of civil engineering. Therefore a comprehensive understanding of the underlying processes and the ability to model and calculate such processes, e.g. with Finite Elements Methods, are necessary.

The graduates for this purpose gain the skills to experimentally determine the necessary properties of soil, materials and components and to deal with construction-specific program systems to calculate mechanical behavior, the hydraulics of systems as well as other physical-chemical processes. They are enabled to work on problems of civil engineering and related disciplines on one's own. They are able to use methods needed for the solution of technical problems and planning procedures. They are able to use new findings in a critical way and to improve methods and new developments.

The graduates can communicate on advanced contents and problems of civil engineering with specialists and the laity. They are able to present their methods and the results of their work in writing and verbally in a comprehensive way. The graduates in addition learn to work on problems in a team in a purposeful way, and to document and present their methods and results understandably with up-to-date presentation methods to other persons. They learn to take the leadership for parts of a project or the whole. They are able to familiarize themselves with a topic and to select suitable methods to solve questions and problems. They are able to acquire the necessary information about a topic on one's own and to put the new information in the context of their knowledge.

The graduates are further qualified to develop concept designs for difficult projects in structural engineering, foundation engineering, bridge design and hydraulic engineering and to plan such constructions under consideration of the available information and restrictions. They can:

- successfully cooperate with expert und inexpert partners from the public administration, the economy and science,
- autonomously define, plan and conduct scientific tasks and to theoretically or experimentally investigate constructions, ground, materials, infrastructure as well as management duties,
- responsibly evaluate and consider the interests of building partners, people concerned and the society as a whole.

By continually switching places of learnings throughout the dual study programme, it is possible for theory and practice to be interlinked. Students reflect theoretically on their individual professional practical experience, and apply the results of their reflection to new forms of practice. They also test theoretical elements of the course in a practical setting, and use their findings as a stimulus for theoretical debate.

#### Program structure

The master program consists of modules which 6 credit points according to ECTS (CP) except for the master thesis. It is divided into a "Core Qualification", into the five alternative specializations "Coastal Engineering", "Geotechnical Engineering", "Structural Engineering", "Water and Traffic" and "Computational Engineering", as well as the master thesis. The core qualification covers 54 CP, each specialization covers 66 CP and the master thesis covers 30 CP. The program covers 150 CP in 2 years with 4 terms in total.

The core qualification contains a module "Finite Elements Methods" as well as a module "Sustainability and Risk Management" in the 1st term. In addition an open module during the 1st, 2nd or 3rd term from the field "Business and Management" as well as a module from the "Non-technical Courses for Master" are incorporated. The lectures of these open modules are selected from catalogs that are independend from the specific master program.

Each specialization covers 42 CP in the compulsory modules, that are indispensable for the specialization, and 24 CP in the mandatory electives. They contain also an open module and a project work with 6 CP in each case. The compulsory modules excepting the project work are located in the 1st and 2nd term.

The 4th term covers the master thesis. In addition lectures of the open module of the specialization can still be attended in the 4th term. The students must select a specialization and they have the choice to elect different options in the field of "Business and Management", in the field of the "Non-technical Courses for Master" and in the mandatory electives of the specialization.

A term abroad is possible. In particular the 3rd semester is used by the students to go abroad, because in the 3rd term there are no compulsory modules, but only mandatory electives.

The structural model of the dual study programme follows a module-differentiating approach. Given the practice-oriented element, the curriculum of the dual study programme is different compared to a standard Bachelor's course. Five practical modules are completed at the dual students' partner company as part of corresponding practical terms during lecture-free periods.

### **Core Qualification**

Module M0523: Busin	ess & Management
March Jac Process of the	
Module Responsible	
Admission Requirements	
<b>Recommended Previous</b>	None
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
Knowledge	<ul> <li>Students are able to find their way around selected special areas of management within the scope of business management.</li> <li>Students are able to explain basic theories, categories, and models in selected special areas of business management.</li> <li>Students are able to interrelate technical and management knowledge.</li> </ul>
Skills	<ul> <li>Students are able to apply basic methods in selected areas of business management.</li> <li>Students are able to explain and give reasons for decision proposals on practical issues in areas of business management.</li> </ul>
Personal Competence	
Social Competence	• Students are able to communicate in small interdisciplinary groups and to jointly develop solutions for complex problems
Autonomy	• Students are capable of acquiring necessary knowledge independently by means of research and preparation of material.
Workload in Hours	Depends on choice of courses
Credit points	6
· · · ·	

### Courses

Information regarding lectures and courses can be found in the corresponding module handbook published separately.

Module Responsible	Dr. Henning Haschke
Admission Requirements	
Recommended Previous	None
Knowledge	<ul> <li>Successful completion of practical modules as part of the dual Bachelor's course</li> </ul>
	<ul> <li>Module "interlinking theory and practice as part of the dual Master's course"</li> </ul>
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Dual students
	can describe and classify selected classic and current theories, concepts and methods
	related to project management and
	change and transformation management
	and apply them to specific situations, processes and plans in a personal, professional context.
Skills	Dual students
	<ul> <li> anticipate typical difficulties, positive and negative effects, as well as success and failure factors in the engine sector, evaluate them and consider promising strategies and courses of action.</li> <li> develop specialised technical and conceptual skills to solve complex tasks and problems in their professional fie activity/work.</li> </ul>
Personal Competence	
Social Competence	Dual students
	<ul> <li> can responsibly lead interdisciplinary teams within the framework of complex tasks and problems.</li> <li> engage in sector-specific and cross-sectoral discussions with experts, stakeholders and staff, representing approaches, points of view and work results.</li> </ul>
Autonomy	Dual students
	define, reflect and evaluate goals and measures for complex application-oriented projects and change processes.
	shape their professional area of responsibility independently and sustainably.
	take responsibility for their actions and for the results of their work.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	Studienbegleitende und semesterübergreifende Dokumentation: Die Leistungspunkte für das Modul werden durch die Anfertig
scale	eines digitalen Lern- und Entwicklungsberichtes (E-Portfolio) erworben. Dabei handelt es sich um eine fortlaufende Dokumenta

Course L2890: Responsible Project Management in Engineering (for Dual Study Program)		
Тур	Seminar	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Dr. Henning Haschke, Heiko Sieben	
Language	DE	
Cycle	WiSe/SoSe	
Content		
Literature	Seminarapparat	

Course L2891: Responsible Change and Transformation Management in Engineering (for Dual Study Program)		
Тур	Seminar	
Hrs/wk	3	
CP	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Dr. Henning Haschke, Heiko Sieben	
Language	DE	
Cycle	WiSe/SoSe	
Cycle       WiSe/SoSe         Content <ul> <li>Basic concepts, opportunities and limits of organisational change</li> <li>Models and methods of organisational design and development</li> <li>Strategic orientation and change, and their short-, medium- and long-term consequences for individuals, organisations an society as a whole</li> <li>Roles, perspectives and stakeholders in change processes</li> <li>Initiating and coordinating change measures in engineering</li> <li>Phase models of organisational change (Lewin, Kotter, etc.)</li> <li>Change-oriented information policy and dealing with resistance and uncertainty</li> <li>Promoting commitment and empowerment</li> <li>Successfully handling change and transformation: personally, as an employee, as a manager (personal, professiona organisational)</li> <li>Company-level and globally (systemic)</li> <li>Sharing experience with specialists and managers from the engineering sector</li> <li>Documenting and reflecting on learning experiences</li> </ul>		
Literature	Seminarapparat	

Courses				
Title		Тур	Hrs/wk	СР
Practical term 1 (dual study progra	n, Master's degree) (L2887)		0	10
Module Responsible	Dr. Henning Haschke			
Admission Requirements	None			
<b>Recommended Previous</b>	Successful completion of a compatible dual B.S	c at TIL Hamburg or comparable	e practical work experier	
Knowledge	in the area of interlinking theory and practice		proceed work experien	ice and competent
	Course D from the module on interlinking theory	ry and practice as part of the dua	al Master's course	
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence	, the racing part succession, statents have reacted	the following learning results		
	Dual students			
	combine their knowledge of facts, principle	es, theories and methods gained	d from previous study c	ontent with acqui
	practical knowledge - in particular their knowle	-		•
	of activity in engineering.			
	• have a critical understanding of the practica	l applications of their engineerin	g subject.	
Skills	Dual students			
	apply technical theoretical knowledge to	complex interdisciplinant probl	ome within the compar	w and evaluate
	<ul> <li>associated work processes and results, taking i</li> </ul>			iy, and evaluate
	<ul> <li> implement the university's application record</li> </ul>			
	develop solutions as well as procedures and			bility.
Personal Competence				
Social Competence	Dual students			
		· · · · · · · · · · · · · · · · · · ·	and the second second second	
	<ul> <li> work responsibly in project teams within the</li> <li> represent complex engineering viewpoints</li> </ul>			
	external stakeholders.	, lacts, problems and solution	approaches in discussio	
4	Dual stude sta			
Autonomy	Dual students			
	define goals for their own learning and work			
	reflect on learning and work processes in the	1 ,	liastica for work of a	
	<ul> <li> reflect on the relevance of subject mode implement the university's application recom</li> </ul>			÷
	between theory and practice.		chancinges to positively	
Werkland in Hours	Independent Study Time 200 Study Time in Lesture (			
Credit points	Independent Study Time 300, Study Time in Lecture (	J		
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Documentation accompanying studies and across ser	nesters: Module credit points are	e earned by completing	a digital learning a
scale	development report (e-portfolio). This documents an	d reflects individual learning ex	periences and skills dev	elopment relating
	interlinking theory and practice, as well as profes	•		rovides proof to
	dual@TUHH Coordination Office that the dual student	has completed the practical pha	ise.	
Assignment for the	Civil Engineering: Core Qualification: Compulsory	n.		
Following Curricula	Bioprocess Engineering: Core Qualification: Compulso Chemical and Bioprocess Engineering: Core Qualificat	-		
	Computer Science: Core Qualification: Compulsory			
	Data Science: Core Qualification: Compulsory			
	Electrical Engineering: Core Qualification: Compulsory	/		
	Energy Systems: Core Qualification: Compulsory			
	Environmental Engineering: Core Qualification: Comp			
	Aircraft Systems Engineering: Core Qualification: Com Computer Science in Engineering: Core Qualification:			
	Information and Communication Systems: Core Qualif			
	International Management and Engineering: Core Qua			
	Logistics, Infrastructure and Mobility: Core Qualification	on: Compulsory		
	Aeronautics: Core Qualification: Compulsory			
	Materials Science and Engineering: Core Qualification	: Compulsory		
	Materials Science: Core Qualification: Compulsory	fication, Compulson		
	Mechanical Engineering and Management: Core Quali Mechatronics: Core Qualification: Compulsory	ilcation: Compulsory		
	Biomedical Engineering: Core Qualification: Compulsory	rv		
	Microelectronics and Microsystems: Core Qualification	1: Compulsory		
	Microelectronics and Microsystems: Core Qualificatior Product Development, Materials and Production: Core			

# Module Manual M.Sc. "Civil Engineering"

Naval Architecture and Ocean Engineering: Core Qualification: Compulsory
Theoretical Mechanical Engineering: Core Qualification: Compulsory
Process Engineering: Core Qualification: Compulsory
Water and Environmental Engineering: Core Qualification: Compulsory

Course L2887: Practical term	1 (dual study program, Master's degree)
Тур	
Hrs/wk	0
CP	10
Workload in Hours	Independent Study Time 300, Study Time in Lecture 0
Lecturer	Dr. Henning Haschke
Language	DE
Cycle	WiSe/SoSe
Content	Company onboarding process
	<ul> <li>Assigning a professional field of activity as an engineer (B.Sc.) and associated fields of work</li> <li>Establishing responsibilities and authorisation of the dual student within the company as an engineer (B.Sc.)</li> <li>Working independently in a team and on selected projects - across departments and, if applicable, across companies</li> <li>Scheduling the current practical module with a clear correlation to work structures</li> <li>Scheduling the examination phase/subsequent study semester</li> </ul> Operational knowledge and skills <ul> <li>Company-specific: Responsibility as an engineer (B.Sc.) in their own area of work, coordinating team and project work, dealing with complex contexts and unsolved problems, developing and implementing innovative solutions <ul> <li>Subject specialisation (corresponding to the chosen course [M.Sc.]) in the field of activity</li> <li>Systemic skills</li> <li>Implementing the university's application recommendations (theory-practice transfer) in corresponding work and task areas across the company</li> </ul></li></ul>
	Sharing/reflecting on learning
	<ul> <li>Creating an e-portfolio</li> <li>Importance of course contents (M.Sc.) when working as an engineer</li> <li>Importance of development and innovation when working as an engineer</li> </ul>
Literature	<ul> <li>Studierendenhandbuch</li> <li>Betriebliche Dokumente</li> <li>Hochschulseitige Handlungsempfehlungen zum Theorie-Praxis-Transfer</li> </ul>

_				
Courses				
Title		Тур	Hrs/wk	СР
Circular Economy (L3264)	210)	Seminar	2	3
Environment and Sustainability (L0		Lecture	2	3
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge		echniques and to give an overview for the	field of safety and risk	assessment, Circu
	Economy as well as environmental and	l sustainable engineering, in detail:		
	<ul> <li>basics in safety and reliability of</li> </ul>	technical facilities		
	<ul> <li>risk assessment and reliability ar</li> </ul>			
	Circularity of material			
	<ul> <li>Identification and evaluation of n</li> </ul>	naterial flows		
	<ul> <li>energy production and supply</li> </ul>			
	<ul> <li>sustainable product design</li> </ul>			
Skills	Students are able apply interdisciplina	ary system-oriented methods for Circularity a	and risk assessment as v	well as sustainabi
	reporting. They can evaluate the effort	and costs for processes and select economica	Ily feasible treatment cor	ncepts.
Personal Competence				
Social Competence				
Autonomy		ubject area from given sources and transform		
		search-oriented duties in for risk managemen	t and sustainability conce	epts accordance w
	the potential social, economic and cultu	iral impact.		
Workload in Hours	Independent Study Time 124, Study Tir	ne in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Elaboration and presentation (45 minut	es in groups)		
scale				
Assignment for the	Civil Engineering: Core Qualification: Co	ompulsory		
-		n C - Bioeconomic Process Engineering, Fo	ocus Management and	Controlling: Elect
<b>J</b>	Compulsory			5
		Specialisation General Process Engineering: El	ective Compulsory	
		Specialisation Bioprocess Engineering: Elective		
		Specialisation Chemical Process Engineering: I		
	Environmental Engineering: Specialisat	ion Energy and Resources: Elective Compulsor	ry	
		oduction: Specialisation Product Development		
		oduction: Specialisation Production: Elective C		
	Product Development, Materials and Pro	oduction: Specialisation Materials: Elective Co	mpulsory	
	Water and Environmental Engineering:			

Course L3264: Circular Economy		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Marco Ritzkowski	
Language	EN	
Cycle	WiSe	
Content		
Literature	Literature	

Course L0319: Environment	and Sustainability
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	<ul> <li>This course presents actual methodologies and examples of environmental relevant, sustainable technologies, concepts and strategies in the field of energy supply, product design, water supply, waste water treatment or mobility.</li> <li>The following list shows examples: <ul> <li>Production and use of biochar</li> <li>Energy production with algae</li> <li>Environmentally friendly product design</li> <li>Clean development mechanisms</li> <li>Democracy and energy</li> <li>Alternative mobility</li> </ul> </li> </ul>
Literature	Wird in der Veranstaltung bekannt gegeben.

Module M2024: Finite	elements			
Courses				
Title		Тур	Hrs/wk	СР
Finite elements (L3279)		Lecture	3	3
Finite elements (L3280)		Recitation Section (large)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
<b>Recommended Previous</b>	Mechanics I/II, Mathematics I/II, Differential Equa	tions I, Structural Analysis I, Structural Analy	sis II, Structural A	Analysis III
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, stu	dents can express theoretical, methodologi	cal and practical	aspects of the fini
	element method.			
Skills	After successfully completing this module, students are able to derive, implement and appropriately apply finite element			
51.005	formulations.			apply mile cleme
Personal Competence				
Social Competence	Students can participate in subject-specific and	interdisciplinary discussions, defend their or	wn work results i	n front of others a
	promote the scientific development of colleague	s. Furthermore, they can give and accept pro	ofessional constru	ictive criticism.
Autonomy	Autonomy Students are able to gain knowledge of the subject area from given and other sources and apply it to new problems. Further		oblems. Furthermor	
	they are able to structure the solution process for	or problems in the area of the finite element i	nethod.	
Workload in Hours	Independent Study Time 110, Study Time in Lec	ture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Core Qualification: Compulsory	/		
Following Curricula				

Course L3279: Finite elemen	Course L3279: Finite elements		
Тур	Lecture		
Hrs/wk	3		
СР	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Prof. Bastian Oesterle		
Language	DE		
Cycle	WiSe		
Content	Direct stiffness method, variational formulation of finite elements, requirements for the approaches, convergence conditions, isoparametric concept finite elements for trusses, beams, disks and plates, locking and alternative FE formulations, basics of model building, mathematical and numerical model, assessment and interpretation of calculation results, Singularities, influence of approximation errors, interactions between mathematical and numerical models		
Literature	Vorlesungsskript		

Course L3280: Finite elemen	ts
Тур	Recitation Section (large)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	WiSe
Content	Direct stiffness method, variational formulation of finite elements, requirements for the approaches, convergence conditions, isoparametric concept finite elements for trusses, beams, disks and plates, locking and alternative FE formulations, basics of model building, mathematical and numerical model, assessment and interpretation of calculation results, Singularities, influence of approximation errors, interactions between mathematical and numerical models
Literature	Vorlesungsskript

Courses				
Title		Тур	Hrs/wk	СР
Practical term 2 (dual study progra	m, Master's degree) (L2888)		0	10
Module Responsible	Dr. Henning Haschke			
Admission Requirements	None			
<b>Recommended Previous</b>	<ul> <li>Successful completion of practical module</li> </ul>	1 as part of the dual Master's course		
Knowledge	course D from the module on interlinking t			
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Knowledge	Dual students			
	<ul> <li> combine their knowledge of facts, prin practical knowledge - in particular their kn of activity in engineering.</li> <li> have a critical understanding of the prace</li> </ul>	owledge of practical professional pro	ocedures and approaches	
Skills	Dual students			
	<ul> <li> apply technical theoretical knowledge associated work processes and results, tak</li> <li> implement the university's application r</li> <li> develop (new) solutions as well as pr including in the case of frequently changin</li> </ul>	ing into account different possible co ecommendations with regard to their ocedures and approaches in their	ourses of action.	
Personal Competence				
Social Competence	Dual students			
	<ul> <li> work responsibly in cross-departmenta their team.</li> </ul>	I and interdisciplinary project teams	s and proactively deal v	vith problems wit
	<ul> <li> represent complex engineering viewpo external stakeholders and develop these fu</li> </ul>		approaches in discussion	ns with internal a
Autonomy	/ Dual students			
	<ul> <li> define goals for their own learning and w</li> <li> reflect on learning and work processes i</li> <li> reflect on the relevance of subject r implement the university's application reduction the between theory and practice.</li> </ul>	n their area of responsibility. nodules specialisations and special		-
Workload in Hours	Independent Study Time 300, Study Time in Lecto	ure 0		
Credit points	10			
Course achievement	None			
Examination	Written elaboration			
Examination duration and scale	Documentation accompanying studies and across development report (e-portfolio). This document interlinking theory and practice, as well as p dual@TUHH Coordination Office that the dual stud	s and reflects individual learning ex rofessional practice. In addition, th	periences and skills devi ne partner company pr	elopment relating
Assignment for the	Civil Engineering: Core Qualification: Compulsory			
Following Curricula	Bioprocess Engineering: Core Qualification: Comp	oulsory		
	Chemical and Bioprocess Engineering: Core Quali			
	Computer Science: Core Qualification: Compulsor	У		
	Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compu	loop		
	Energy Systems: Core Qualification: Compulsory	ISOI ý		
	Environmental Engineering: Core Qualification: Co	ompulsory		
	Aircraft Systems Engineering: Core Qualification:	Compulsory		
	Computer Science in Engineering: Core Qualificat	ion: Compulsory		
	Information and Communication Systems: Core Q			
	International Management and Engineering: Core			
	Logistics, Infrastructure and Mobility: Core Qualifi Aeronautics: Core Qualification: Compulsory	санон: сотривогу		
	Materials Science and Engineering: Core Qualifica	ation: Compulsory		
	Materials Science: Core Qualification: Compulsory			
	Mechanical Engineering and Management: Core C	Qualification: Compulsory		
	Mechatronics: Core Qualification: Compulsory			
	Biomedical Engineering: Core Qualification: Comp			
	Microelectronics and Microsystems: Core Qualification Product Development, Materials and Production:			
	Product Development, Materials and Production:	Core Quanneacion. Compuisory		

# Module Manual M.Sc. "Civil Engineering"

Renewable Energies: Core Qualification: Compulsory
Naval Architecture and Ocean Engineering: Core Qualification: Compulsory
Theoretical Mechanical Engineering: Core Qualification: Compulsory
Process Engineering: Core Qualification: Compulsory
Water and Environmental Engineering: Core Qualification: Compulsory

Course L2888: Practical term	1 2 (dual study program, Master's degree)
Тур	
Hrs/wk	0
СР	10
Workload in Hours	Independent Study Time 300, Study Time in Lecture 0
Lecturer	Dr. Henning Haschke
Language	DE
Cycle	WiSe/SoSe
Content	Company onboarding process
	<ul> <li>Assigning a professional field of activity as an engineer (B.Sc.) and associated fields of work</li> <li>Establishing responsibilities and authorisation of the dual student within the company as an engineer (B.Sc.)</li> <li>Taking personal responsibility within a team and on selected projects - across departments and, if applicable, across companies</li> <li>Scheduling the current practical module with a clear correlation to work structures</li> <li>Scheduling the examination phase/subsequent study semester</li> </ul> Operational knowledge and skills <ul> <li>Company-specific: Responsibility as an engineer (B.Sc.) in their own area of work, coordinating team and project work, dealing with complex contexts and unsolved problems, developing and implementing innovative solutions <ul> <li>Subject specialisation (corresponding to the chosen course [M.Sc.]) in the field of activity</li> <li>Systemic skills</li> <li>Implementing the university's application recommendations (theory-practice transfer) in corresponding work and task areas across the company</li> </ul></li></ul>
	Sharing/reflecting on learning
	<ul> <li>Updating their e-portfolio</li> <li>Importance of course contents (M.Sc.) when working as an engineer</li> <li>Importance of development and innovation when working as an engineer</li> </ul>
Literature	<ul> <li>Studierendenhandbuch</li> <li>Betriebliche Dokumente</li> <li>Hochschulseitige Anwendungsempfehlungen zum Theorie-Praxis-Transfer</li> </ul>

Courses				
Title		Тур	Hrs/wk	СР
Practical term 3 (dual study progra	m, Master's degree) (L2889)		0	10
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	<ul><li>Successful completion of practical module</li><li>course E from the module on interlinking the</li></ul>	•		
Educational Objectives	After taking part successfully, students have read	hed the following learning results		
Professional Competence				
Knowledge	Dual students			
	<ul> <li> combine their comprehensive and spe- strategy-oriented practical knowledge gain</li> <li> have a critical understanding of the pri implementing innovations.</li> </ul>	ed from their current field of work a	nd area of responsibility.	
Skills	Dual students			
	<ul> <li> apply specialised and conceptual skills evaluate the associated work processes an</li> <li> implement the university's application re</li> <li> develop new solutions as well as proceed when facing frequently changing requirem</li> <li> can use academic methods to develop these with regard to their usability.</li> </ul>	d results, taking into account differe ecommendations with regard to thei dures and approaches to implement ents and unpredictable changes (sys	ent possible courses of act r current tasks. coperational projects and stemic skills).	ion. assignments - ev
Personal Competence				
Social Competence	Dual students			
	<ul> <li> work responsibly in cross-departmenta their team.</li> <li> can promote the professional development</li> </ul>	ent of others in a targeted manner.		
	<ul> <li> represent complex and interdisciplinary with internal and external stakeholders and</li> </ul>		plems and solution appro-	aches in discussio
Autonomy	Dual students			
	<ul> <li> reflect on learning and work processes i</li> <li> define goals for new application-oriente company and the public.</li> <li> reflect on the relevance of areas of university's application recommendations and practice.</li> </ul>	d tasks, projects and innovation pla	rk as an engineer, and	also implement t
Workload in Hours	Independent Study Time 300, Study Time in Lect	ure 0		
Credit points				
Course achievement				
Examination	Written elaboration			
Examination duration and scale	Documentation accompanying studies and across development report (e-portfolio). This document interlinking theory and practice, as well as p dual@TUHH Coordination Office that the dual stur	s and reflects individual learning ex rofessional practice. In addition, t	operiences and skills deve he partner company pro	elopment relating
Assignment for the	Civil Engineering: Core Qualification: Compulsory			
Following Curricula	Bioprocess Engineering: Core Qualification: Comp	ulsory		
	Chemical and Bioprocess Engineering: Core Quali	fication: Compulsory		
	Computer Science: Core Qualification: Compulsor	у		
	Data Science: Core Qualification: Compulsory	son		
	Electrical Engineering: Core Qualification: Compu Energy Systems: Core Qualification: Compulsory	SOLA		
	Environmental Engineering: Core Qualification: Co	ompulsory		
	Aircraft Systems Engineering: Core Qualification:			
	Computer Science in Engineering: Core Qualificat			
	Information and Communication Systems: Core Q			
	International Management and Engineering: Core Logistics, Infrastructure and Mobility: Core Qualifi			
	•	cation. Compuisory		
	Materials Science and Engineering: Core Qualifica	tion: Compulsory		
	Aeronautics: Core Qualification: Compulsory Materials Science and Engineering: Core Qualifica			

# Module Manual M.Sc. "Civil Engineering"

Materials Science: Core Qualification: Compulsory
Mechanical Engineering and Management: Core Qualification: Compulsory
Mechatronics: Core Qualification: Compulsory
Biomedical Engineering: Core Qualification: Compulsory
Microelectronics and Microsystems: Core Qualification: Compulsory
Product Development, Materials and Production: Core Qualification: Compulsory
Renewable Energies: Core Qualification: Compulsory
Naval Architecture and Ocean Engineering: Core Qualification: Compulsory
Theoretical Mechanical Engineering: Core Qualification: Compulsory
Process Engineering: Core Qualification: Compulsory
Water and Environmental Engineering: Core Qualification: Compulsory

Course L2889: Practical term	n 3 (dual study program, Master's degree)
Тур	
Hrs/wk	0
CP	10
Workload in Hours	Independent Study Time 300, Study Time in Lecture 0
Lecturer	Dr. Henning Haschke
Language	DE
Cycle	WiSe/SoSe
Content	Company onboarding process
	<ul> <li>Assigning a future professional field of activity as an engineer (M.Sc.) and associated fields of work</li> <li>Extending responsibilities and authorisation of the dual student within the company up to the intended first assignment after completing their studies</li> <li>Working responsibly in a team; project responsibility within own area - as well as across divisions and companies if necessary</li> <li>Scheduling the final practical module with a clear correlation to work structures</li> <li>Internal agreement on a potential topic or innovation project for the Master's dissertation</li> <li>Planning the Master's dissertation within the company in cooperation with TU Hamburg</li> <li>Scheduling the examination phase/subsequent study semester</li> </ul>
	Operational knowledge and skills
	<ul> <li>Company-specific: dealing with change, project and team development, responsibility as an engineer in their future field of work (M.Sc.), dealing with complex contexts, frequent and unpredictable changes, developing and implementing innovative solutions</li> <li>Specialising in one field of work (final dissertation)</li> <li>Systemic skills</li> <li>Implementing the university's application recommendations (theory-practice transfer) in corresponding work and task areas across the company</li> </ul>
	Sharing/reflecting on learning     E-portfolio
	<ul> <li>Relevance of study content and personal specialisation when working as an engineer</li> <li>Relevance of research and innovation when working as an engineer</li> </ul>
Literature	<ul> <li>Studierendenhandbuch</li> <li>betriebliche Dokumente</li> <li>Hochschulseitige Anwendungsempfehlungen zum Theorie-Praxis-Transfer</li> </ul>

# **Specialization Coastal Engineering**

Module M0699: Geote	echnics III			
Courses				
Title		Тур	Hrs/wk	СР
Numerical Methods in Geotechnics	(L0375)	Lecture	3	3
Advanced Foundation Engineering	(L0497)	Lecture	2	2
Advanced Foundation Engineering	(L0498)	Recitation Section (large)	1	1
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
<b>Recommended Previous</b>	Geotechnics I and II, Mathematics I-III			
Knowledge				
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Knowledge	After successfully completing the module, studen	ts will be able to		
	<ul> <li>describe individual procedures for the geot</li> </ul>	echnical monitoring of civil engineering	measures	
	<ul> <li>reproduce exploration and investigation m</li> </ul>		ilcusules,	
	<ul> <li>select suitable types of field and laboratory</li> </ul>		ate their results	
	<ul> <li>state the differences between various stress</li> </ul>			variants of the stress
	and distortion tensor,	so and deformation states and the physic	an significance of in	variants of the stress
	<ul> <li>outline the standard and special soil mecha</li> </ul>	anics tests used to determine the stress-	strain behavior of so	il.
	<ul> <li>describe continuum models and the resulti</li> </ul>			,
	<ul> <li>as well as define boundary value problems</li> </ul>		ng in such a wav tha	t they can be solved
	unambiguously.		5	2
Skills	Students will be able to			
	<ul> <li>dimension vertical drains for soil improvement of soft soils,</li> <li>calculate depth compaction using various appropriate methods,</li> <li>apply principles of horizontal bearing capacity of piles,</li> <li>verify the internal and external stability of fluid-supported diaphragm walls,</li> <li>evaluate the boundary conditions for the design of a deep excavation and design the individual components of the excavation</li> </ul>			
				components of the
	excavation,			
	<ul> <li>perform, evaluate and interpret tests for the description and classification of soils according to applicable standards,</li> <li>computationally implement numerical algorithms to solve boundary value problems</li> </ul>			
	<ul> <li>computationally implement numerical algorithms to solve boundary value problems,</li> <li>select and apply the types of analyses depending on the degree of saturation, the impact, and the material behavior</li> </ul>			
	<ul> <li>determine appropriate model parameters for different possibilities and limitations of material models for the grain structu</li> </ul>			
	of soils.			, the grain budecare
Personal Competence				
Social Competence	Students can work in groups and support each ot	her in finding solutions.		
Autonomy	Students are able to assess their own strengths a and think in terms of processes.	nd weaknesses and, based on this, organ	nize their time and le	earning management
Workload in Hours	Independent Study Time 96, Study Time in Lectur	re 84		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engine	eering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng	gineering: Compulsory		
	Civil Engineering: Specialisation Coastal Engineer	• • •		
	Civil Engineering: Specialisation Water and Traffic			
	Civil Engineering: Specialisation Computational En			
	International Management and Engineering: Spec	cialisation II. Civil Engineering: Elective Co	ompulsory	

Course L0375: Numerical Me	Course L0375: Numerical Methods in Geotechnics		
Тур	Lecture		
Hrs/wk	3		
СР	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Dr. Hans Mathäus Stanford		
Language	DE		
Cycle	WiSe		
Content	Topics:		
	<ul> <li>Introduction to numerical soil mechanics</li> <li>Introduction to numerical mathematics</li> <li>Finite Element Method (analysis procedures, algorithms)</li> <li>Finite Element Method (application in geotechnical engineering)</li> </ul>		
Literature	<ul> <li>Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden. Springer</li> <li>Wriggers P. (2008): Nonlinear Finite Element Methods. Springer</li> <li>Deutsche Gesellschaft für Geotechnik e.V. (Hrsg., 2014): Empfehlungen des Arbeitskreises "Numerik in der Geotechnik". Ernst &amp; Sohn</li> </ul>		

Course L0497: Advanced Fou	Indation Engineering			
Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	endent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Jürgen Grabe			
Language	DE			
Cycle	WiSe			
Content	<ul> <li>Vertical drains</li> <li>Piles</li> <li>Ground improvement (Deep Compaction, Soil mixing)</li> <li>Vibration driving</li> <li>Jet grouting</li> <li>Slurry wall</li> <li>Deep excavation</li> </ul>			
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>EAB (1988): Empfehlungen des Arbeitskreises Baugruben</li> <li>Grundbau-Taschenbuch, Teil 1-3, (1997), Ernst &amp; Sohn Verlag</li> </ul>			

Course L0498: Advanced Fou	undation Engineering
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses							
Title			Тур	Hrs/wk	CP		
Applied Tunnel Constructions (L24)			Lecture	2	3		
Introduction to tunnel construction (L0707) Introduction to tunnel construction (L1811)			Lecture Recitation Section (large)	1	2		
Module Responsible			Rectation Section (large)	1	-		
Admission Requirements							
Recommended Previous		idias Civil and anvironma	ntal anginagring.				
Kecommended Previous Knowledge	Modules from Bachelor st		ntal engineering:				
Kilowieuge	Geotechnics I-II						
Educational Objectives	After taking part successf	Illy students have reach	ad the following learning results				
Professional Competence	Arter taking part successi	After taking part successfully, students have reached the following learning results					
	Knowledge of different tunnel construction types as well as special methods and techniques of subsoil construction.						
-	Basic knowledge of tunnel design as well as practical skills in structural tunnel analysis.						
Personal Competence	Sasic knowledge of turnel design as well as practical skills in structural turnel analysis.						
-	Capacity for teamwork concerning project management and design of tunnels.						
,	Promotion of independent and creative work flow in the framework of a design exercise.						
	ndependent Study Time 124, Study Time in Lecture 56						
Credit points		124, Study Time in Lectur					
Course achievement		m	Description				
course demovement		cercises					
Examination	Written exam						
Examination duration and	120 minutes						
scale							
Assignment for the	Civil Engineering: Speciali	sation Structural Enginee	ring: Elective Compulsory				
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Compulsory						
	Civil Engineering: Speciali	sation Coastal Engineerin	g: Compulsory				
	Civil Engineering: Speciali	sation Water and Traffic:	Elective Compulsory				
	Civil Engineering: Speciali	sation Computational Eng	ineering: Elective Compulsory				

Course L2407: Applied Tunne	el Constructions			
Тур	Lecture			
Hrs/wk				
СР	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	rgen Grabe, Tim Babendererde			
Language	DE			
Cycle	WiSe			
Content				
Literature				

Course L0707: Introduction t	o tunnel construction			
Тур	Lecture			
Hrs/wk	1			
СР	2			
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14			
Lecturer	ulian Bubel			
Language	DE			
Cycle	WiSe			
Content	<ul> <li>Definitions</li> <li>Historical development in tunneling</li> <li>Geology for tunneling</li> <li>Hard rock tunneling (construction composite and machines)</li> <li>Tunnelung in temporarly stable soil with conventional construction methods</li> <li>Tunneling in soft soils (form of supports, shield types, compressed air application)</li> <li>Pipe jacking</li> <li>Tunnel Lining, tunnel supporting structures</li> <li>Calculation approaches for supporting structures in shield-driven tunnels</li> <li>Surveying for tunneling</li> <li>Safety requirements</li> <li>Construction Contract</li> <li>Literature and sources</li> </ul>			
Literature	• Vorlesung/Übung s. www.tu-harburg.de/gbt			

Course L1811: Introduction t	Course L1811: Introduction to tunnel construction			
Тур	Recitation Section (large)			
Hrs/wk				
CP	1			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Dr. Julian Bubel			
Language	DE			
Cycle	WiSe			
Content	See interlocking course			
Literature	See interlocking course			

ect-/problem-based Learning	Hrs/wk	СР
, J		6
		0
arning results		
pulsory		
ry		
lsory		
ompulsory		
Compulsory		
e Compulsory		
0	ompulsory Compulsory Compulsory	ompulsory Compulsory

Course L2867: Construction	Robotics			
Тур	Project-/problem-based Learning			
Hrs/wk	6			
СР	6			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Lecturer	Prof. Kay Smarsly, Jan Stührenberg			
Language				
Cycle	WiSe			
Content	<ol> <li>Introduction: Robotics in civil engineering</li> <li>Presentation of potential topics</li> <li>Programming of algorithms in Python</li> <li>Application of software systems: LINUX distribution, ROS, CloudCompare,</li> <li>Application of hardware systems: Petoi Bittle Dog, Raspberry Pi, Arduino, sensing</li> <li>Topics considered for robotics using the Petoi Bittle Dog:         <ol> <li>Movement</li> <li>Use of sensors (camera, infrared,)</li> <li>Data structures/data acquisition</li> <li>Programming</li> </ol> </li> <li>Topics technically relevant to building inspection:         <ol> <li>Geodetic evaluations</li> <li>Image processing</li> <li>Localization</li> </ol> </li> </ol>			
Literature	Bock/Linner: Construction Robotics			
	Verl et al.: Soft Robotics			
	Pasquale: New Laws of robotics			

Courses				
Title		Тур	Hrs/wk	СР
Digital Twinning in Civil Engineerin	g (L3136)	Lecture	2	2
Digital Twinning in Civil Engineerin	g (L3137)	Seminar	2	4
Module Responsible	Alexander Chmelnizkij			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	20 min presentation and 5 pages handou	t		
scale				
Assignment for the	Civil Engineering: Specialisation Compute	ational Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structura	al Engineering: Elective Compulsory		

Course L3136: Digital Twinni	Course L3136: Digital Twinning in Civil Engineering		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly		
Language	DE		
Cycle	SoSe		
Content			
Literature			

Course L3137: Digital Twinn	ing in Civil Engineering
Тур	Seminar
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

## Module M0593: Building Materials and Building Preservation

Courses							
Title			Тур		Hrs/wk	СР	
Repair of Structures (L0255)			Lectu	ıre	1	1	
Mineral Building Materials (L0253)			Lectu	ıre	2	2	
Technology of mineral Building Mat	erials (L0256)		Proje	ct-/problem-based Learning	1	2	
Transport Processes in Building Ma	erials and Damage Processes (L02	54)	Lectu	ıre	1	1	
Module Responsible	Prof. Frank Schmidt-Döhl						
Admission Requirements	None						
<b>Recommended Previous</b>	Basic knowledge about building materials, building physics and building chemistry, for example by the modules Principles o						
Knowledge	Building Materials and Building	Physics and Buildin	ng Materials and Bui	lding Chemistry.			
Educational Objectives	After taking part successfully, s	tudents have reac	hed the following lea	irning results			
Professional Competence							
Knowledge	The students are able to descri	be the components	s of mineral building	materials and their function	on in detail and	d to use them for t	
	manufacture of special mineral	building materials	. They are able to sh	ow the characteristics of m	nineral buildin	g materials. They a	
	able to describe the manufactu	re, properties and	fields of application	of special mortars and spe	cial concretes	and the correlation	
	of their material parameters. Th	ney are able to sho	w the principles of a	nchor technology and desi	gn.		
Chille	The shudents are able to reaf-		- f		These and a bi		
SKIIIS	The students are able to perfor			-		• •	
	mineral mortar and to manufac						
	able to recognize damages, to assess possible causes, to use the fundamentals of construction preservation and to sele and strengthening measures.						
Personal Competence							
Social Competence							
	other students. In a critical discussion they defend and adjust their results. The students are able to manufacture the					ifacture their spec	
	building material on the basis of this feedback.						
Autonomy	The students are able to respo	nsibly use the reso	ources of materials a	and lab equipment for their	r project and	to investigate and	
	get missing components.						
Workload in Hours	Independent Study Time 110, S	itudy Time in Lectu	ire 70				
Credit points	6						
Course achievement	Compulsory Bonus Form		Description				
	Yes 20 % Subject	theoretical an	ıd				
	practica	l work					
Examination	Written exam						
Examination duration and	120 min						
scale							
Assignment for the	Civil Engineering: Specialisatior	n Geotechnical Eng	ineering: Compulsor	У			
Following Curricula	Civil Engineering: Specialisatior	n Coastal Engineeri	ing: Elective Compul	sory			
	Civil Engineering: Specialisatior	n Structural Engine	ering: Elective Comp	oulsory			
	Civil Engineering: Specialisatior						

Course L0255: Repair of Structures		
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Maintenance of structures, repair and strengthening, subsequent waterproofing of structures	
Literature	BetonMarketing Deutschland (Hrsg.): Stahlbetonoberflächen - schützen, erhalten, instandsetzen	

Course L0253: Mineral Buildi	ing Materials
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	SoSe
Content	Components of mineral building materials and their function, binding materials, concrete and mortar, special mortars, special concretes
Literature	Taylor, H.F.W.: Cement Chemistry
	Springenschmid, R.: Betontechnologie für die Praxis

Course L0256: Technology of mineral Building Materials		
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Design and production of a special mineral building material	
Literature	aylor, H.F.W.: Cement Chemistry	
	Springenschmid, R.: Betontechnologie für die Praxis	

Course L0254: Transport Processes in Building Materials and Damage Processes	
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	SoSe
Content	Transport Processes in Building Materials and Damage Processes
Literature	Blaich, J.: Bauschäden, Analyse und Vermeidung

Courses				
Title		Тур	Hrs/wk	СР
Design of Prestressed Structures and Concreet Bridges (L0603)		Lecture	3	4
Design of Prestressed Structures a	nd Concreet Bridges (L0604)	Recitation Section (large)	2	2
Module Responsible	NN			
Admission Requirements	None			
<b>Recommended Previous</b>	Detailed knowledge on the design of concr	ete structures.		
Knowledge				
	Modules: Reinforced Concrete Structures I-	+II, Structural Analysis I+II, Mechanics I+II, Concre	te Structures	
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	<i>e</i> The students know the main bridge types, their applications and the various loads. They can explain the basic design in They can explain the design of a prestressed bridge.			
Skills	The students are able to design reinforced or prestressed concrete bridges.			
Personal Competence				
Social Competence	The students can design in teamwork a real concrete bridge.			
	-			
Autonomy	The students are able to design a prestress	sed concrete bridge and discuss the problems and	results with othe	r students.
Workload in Hours	Independent Study Time 110, Study Time i	in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 minutes			
scale				
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Compulsory		
-	Civil Engineering: Specialisation Geotechni			
-	Civil Engineering: Specialisation Coastal En	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Computati	ional Engineering: Elective Compulsory		
	International Management and Engineering			

Course L0603: Design of Pre	stressed Structures and Concreet Bridges
Тур	Lecture
Hrs/wk	
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	NN
Language	DE
Cycle	SoSe
Content	prestressed structures
	<ul> <li>basis of prestressed structures, field of application</li> <li>differences between reinforced and prestressed concrete structures</li> <li>history of prestressing</li> <li>construction materials: concrete, tendons, ducts, anchorage systems</li> <li>construction: prestressing methods</li> <li>prestressing forces and member forces (friction, elongation)</li> <li>tendon layout</li> <li>time dependant prestressing losses</li> <li>design of prestressed structures</li> <li>design of anchorage region</li> <li>non-bonded prestressing</li> <li>prestressed flat slabs</li> </ul>
	Concrete bridges <ul> <li>history of bridges</li> <li>design of bridges</li> <li>loads on bridges</li> <li>loads on bridges</li> <li>member forces for slab, T-beam, hollow box, frame and arch bridges</li> <li>precast bridges - precast segmental bridges</li> <li>bearings</li> <li>abutments, columns</li> <li>construction methods</li> <li>damages - checking of bridges</li> </ul>
Literature	<ul> <li>Vorlesungsumdruckim STUDiP</li> <li>Rombach, G. (2003): Spannbetonbau. Ernst &amp; Sohn, Berlin</li> <li>Wicke, M. (2002): Anwendung des Spannbetons. Betonkalender 2002, Teil II, S. 113-180, Verlag Ernst &amp; Sohn, Berlin</li> <li>Leonhardt, F. (1980): Vorlesungen über Massivbau. Teil 5: Spannbeton. Berlin</li> <li>Mehlhorn, G. (2007): Handbuch Brücken, Springer Verlag</li> <li>Schäfer, H.; Kaufeld, K. (1997): Massivbrücken. Betonkalender Teil II, S. 443ff, Ernst &amp; Sohn, Berlin</li> <li>Menn, Ch. (1986): Stahlbetonbrücken. Springer Verlag, Wien</li> </ul>

Course L0604: Design of Pre	ourse L0604: Design of Prestressed Structures and Concreet Bridges	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	NN	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses					
Title			Тур	Hrs/wk	СР
Soil Mechanics - Selected Topics (L	0374)		Lecture	2	2
Soil Dynamics (L0452)			Lecture	2	2
Experimental Researches in Geote	hnics (L0706)		Practical Course	2	2
Module Responsible	Prof. Jürgen Grabe				
Admission Requirements	None				
<b>Recommended Previous</b>	Modules: Mathematics I-III, Me	chanics I-II, Geotechnic	s l		
Knowledge	Courses: Soil laboratory course	e, (Applied structural dy	vnamics)		
Educational Objectives	After taking part successfully,	students have reached	the following learning results		
Professional Competence					
	Students will be able to,				
	e docaribo wayo propaga	ion in the ground unde	r dynamic availation and define th	a relevant narameters	
			r dynamic excitation and define the		
			obtained with regard to their effection of the standard standar		
	<ul> <li>to reproduce the collaps</li> </ul>		ent and when plastodynamic effec	is must be taken mito	account,
			ils and computationally account f	ior croop deformation	and rate depende
		enavior of conesive so	is and computationally account i		and rate-depende
	<ul><li>shear strengths</li><li>as well as to determine</li></ul>	the effect of partial sat	uration on the seepage flow and th	e shear strength.	
<i></i>					
Skills	After the successful completio	n of the module the stu	dents should be able to:		
	<ul> <li>to derive and apply the basic equation of a simple mass oscillator,</li> <li>to understand the wave propagation in the soil under dynamic excitation and to detect the relevant parameters,</li> <li>to know the essential laboratory and field tests to determine soil dynamic characteristics and to evaluate them,</li> <li>to design machine foundations to dynamic load,</li> </ul>				
	<ul> <li>to measure shocks to perform to measure shocks to perform the shocks to per</li></ul>	erform vibration forecas	st,		
	<ul> <li>to evaluate shocks in te</li> </ul>	rms of their effect on p	eople and buildings,		
	<ul> <li>to evaluate possibilities</li> </ul>	of isolation,			
	<ul> <li>to understand mechanis</li> </ul>	sms that cause earthqu	akes and evaluate earthquakes in	terms of their magnitu	ude and intensity,
	<ul> <li>to know methods to det</li> </ul>	ermine axial pile capac	ity, integrity, and the dynamic bed	ding modulus,	
	<ul> <li>to know the mechanism mathematically,</li> </ul>	is that lead to a deform	nation accumulation due to cyclic l	oading and to estimat	e these deformatio
	<ul> <li>to distinguish the area</li> </ul>	of application of the me	thod of elastodynamics and plasto	dynamics,	
	<ul> <li>to detect the undrained</li> </ul>	shear strength as a fur	nction of a number of state variable	25,	
	<ul> <li>to capture the visous be</li> </ul>	ehaviour of cohesive so	ils and to consider the effects of c	reep and rate-depend	lent shear strength
	calculations,				
	• to consider the impact of	of the partly saturated of	of a seepage and shear strength.		
Personal Competence					
• Social Competence	Students will be able to work	in teams to achieve re	sults on measurement and experi	mental principles and	present their resu
,	together at the end of the sem				
Autonomy	Students are able to assess th	eir own strengths and v	veaknesses and organize their time	e and learning manage	ement based on thi
Workload in Hours	Independent Study Time 96, S 6	tudy Time in Lecture 84	1		
Credit points Course achievement	Compulsory Bonus Form	De	scription		
course achievement		theoretical and	-		
	practic	al work			
Examination	Written exam				
Examination duration and	135 min				
scale Assignment for the	Civil Engineering: Specialisatio	n Structural Engineeria	a: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisatio				
	CIVIL ENGINEERING, SDECIGISALL				
i onoring curricula	Civil Engineering: Specialisatio				

Course L0374: Soil Mechanic	s - Selected Topics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Hans Mathäus Stanford
Language	DE
Cycle	SoSe
Content	selected topis:
Literature	<ul> <li>Stress-strain behaviour (experiments, observations, models)</li> <li>Hydraulic behaviour (experiments, observations, models)</li> <li>Physical modelling (similarity theory, 1g model tests, ng model tests)</li> <li>Limit and safety analysis (collapse theorems of plasticity theory, upper and lower bound analysis, limit equilibrium analysis, numerical analysis)</li> <li>Heat transport (heat conduction, convective heat transport, freezing/thawing)</li> <li>Kolymbas D. (2019): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. Springer Verlag, 5. Auflage</li> <li>Muir Wood D. (2004). Geotechnical modelling. CRC Press</li> <li>Nova, R. (2010). Soil mechanics. Wiley</li> <li>Verruijt, A. (2012). Soil mechanics. u r l: https://geo.verruijt.net</li> <li>Verruijt A. (2018). An introduction to soil mechanics. Vol. 30, Springer Series Theory and Applications of Transport in Porous Media</li> </ul>

Course L0452: Soil Dynamics					
Тур	Lecture				
Hrs/wk	2				
СР	2				
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
Lecturer	Anne Hagemann				
Language					
Cycle	SoSe				
Content	• mass-spring-damper systems,				
	• wave propagation in soils,				
	• dynamic soil parameters,				
	Determination of dynamic soil parameters,				
	nachine foundations,				
	• in-situ measurement of ground motion, ground motion prediction, evaluation of ground motion,				
	• ground motion shielding,				
	• introduction into earthquake engineering,				
	• dynamic pile tests,				
	• cyclic accumulation,				
	• plastodynamics				
Literature	<ul> <li>Das B.M.: Fundamentals of Soil Dynamics, Elsevier</li> <li>Empfehlungen des Arbeitskreises Baugrunddynamik. Hrsg. Deutsche Gesellschaft für Geotechnik (DGGT)</li> <li>Haupt W.: Bodendynamik. Vieweg und Teubner</li> <li>Meskouris K. und Hinzen KG.: Bauwerke und Erdbeben. Vieweg Verlag</li> <li>Studer J.A., Koller M.G. und Laue J.: Bodendynamik, Springer Verlag</li> </ul>				

Course L0706: Experimental	Researches in Geotechnics
Тур	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Hans Mathäus Stanford, Göta Bürkner
Language	DE
Cycle	SoSe
Content	<ul> <li>The students are supposed to:</li> <li>become acquainted with geotechnical model tests, field tests and laboratory tests as well as corresponding measurement techniques. These compromise amongst others inclinometer measurements and geophone measurements as well as high-grade laboratory tests on the stress-strain relationship of soil specimens, e. g. triaxial tests, simple shear tests and resonant</li> </ul>
	<ul> <li>column tests.</li> <li>gain insight into current soil mechanical research.</li> <li>plan, coordinate, perform and evaluate soil mechanical tests in a team.</li> <li>discuss, reflect, review and present the obtained results in a group.</li> </ul>
	An important learning target is the introduction to scientific work for students who plan a scientific career, and for those who will work in practice with the responsibility to order corresponding tests and evaluate the results. The practical laboratory work is based on annualy changing problems, which are however related to the experience and results of
	the preceding year's course group.
Literature	- Grabe, J. (2004): Bodenmechanik und Grundbau, Band 3 der Veröffentlichungsreihe des Instituts für Geotechnik und Baubetrieb, Technische Universität Hamburg-Harburg.
	- Kolymbas, D. (2007): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. 2., korrigierte und ergänzte Auflage, Springer Verlag.
	<ul> <li>Normen zu geotechnischen Versuchsgeräten und Versuchsverfahren:</li> <li>DIN 18135:2012-04: Baugrund, Untersuchung von Bodenproben -</li> <li>Eindimensionaler Kompressionsversuch, Deutsches Institut für</li> <li>Normung, e. V.</li> </ul>
	- DIN 18137-2:2011-04: Baugrund, Untersuchung von Bodenproben - Bestimmung der Scherfestigkeit - Teil 2: Triaxialversuch, Deutsches Institut für Normung e. V.

Courses Fitle Groundwater Modeling using Modflov Groundwater Modeling using Modflov Modeling of Water Supply Network (I Module Responsible [	v (L0544) .0875) Dr. Klaus Johannsen	<b>Typ</b> Lecture Recitation Section (small)	Hrs/wk	СР	
Fitle Groundwater Modeling using Modflov Groundwater Modeling using Modflov Modeling of Water Supply Network (I Module Responsible	v (L0544) .0875) Dr. Klaus Johannsen	Lecture	- /	CP	
Groundwater Modeling using Modflov Groundwater Modeling using Modflov Modeling of Water Supply Network (L Module Responsible	v (L0544) .0875) Dr. Klaus Johannsen	Lecture	- /	CP	
Groundwater Modeling using Modflov Modeling of Water Supply Network (I Module Responsible	v (L0544) .0875) Dr. Klaus Johannsen			CF	
Modeling of Water Supply Network (L Module Responsible	.0875) Dr. Klaus Johannsen	Recitation Section (small)	1	1	
Module Responsible	Dr. Klaus Johannsen	Project-/problem-based Learning	2 2	2 3	
-		Project-problem-based Learning	Z	5	
Admission Requirements					
Recommended Previous					
Knowledge	Siounawater				
	<ul> <li>groundwater hydraulics and transport of substar</li> </ul>	ices			
1	Pipe Systems				
	Knowledge on urban water infrastructures, in	particular drinking water systemsand u	irban drainagi	e systems includin	
	special structures	cowor systems			
	<ul> <li>Hydraulics of drinking water supply systems and</li> <li>Basic knowledge on water management</li> </ul>	Sewer Systems			
Educational Objectives	After taking part successfully, students have reached the	ne following learning results			
<b>Professional Competence</b>					
Knowledge	The students are able to describe the modelling of groundwater flow and transport as well as urban water infrastructures. They c				
	carry out systems analyses and can detect technical and conceptual weak points within the systems in case studies. Besides				
ā	are able to analyse interdependencies of hydraulic and toxic phenomena in soil and water.				
	The students are able to construct and apply scientific groundwater models indipendently. They can work on different science and can compare or assess different solutions for existing problems by application of selected software products. The students able to use different software colutions (or a EDANET EDA SWMM)				
c	able to use different software solutions (e.g. EPANET, EPA-SWMM).				
Personal Competence					
Social Competence	Nird nicht vermittelt.				
Autonomy	Vird nicht vermittelt.				
	ndependent Study Time 110, Study Time in Lecture 70				
Credit points					
Course achievement					
Examination (					
Examination duration and 3 scale	30 min				
	Tivil Engineering, Specialization Structural Engineering	Elective Compulson			
-	Civil Engineering: Specialisation Structural Engineering Civil Engineering: Specialisation Geotechnical Engineer				
-	Civil Engineering: Specialisation Geotechnical Engineering: E	•			
	Civil Engineering: Specialisation Coastal Engineering: E				
	Civil Engineering: Specialisation Computational Engineering				
	Vater and Environmental Engineering: Specialisation E				
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory				
	Nater and Environmental Engineering: Specialisation W				

Course L0543: Groundwater Modeling using Modflow		
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Sonja Götz	
Language	DE/EN	
Cycle	SoSe	
Content	Introduction and application of the groundwater model MODFLOW (PMWIN); theoretical backround of the modell, students do work	
	with the model PMWIN for practical case studies.	
Literature	MODFLOW-Handbuch	
	Chiang, Wen Hsien: PMWIN	

Course L0544: Groundwater	urse L0544: Groundwater Modeling using Modflow		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Sonja Götz		
Language	DE/EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0875: Modeling of Water Supply Network		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Klaus Johannsen	
Language	DE	
Cycle	SoSe	
Content		
Literature	Mutschmann/Stimmelmayr: Taschenbuch der Wasserversorgung, 16. Auflage. Springer Vieweg - Verlag. Wiesbaden 2014.	

Courses				
Title		Тур	Hrs/wk	СР
Noise Protection (L1109)		Lecture	2	2
Urban Infrastructures (L0874)		Project-/problem-based Learning	2	4
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
<b>Recommended Previous</b>	Knowledge on Urban planning			
Knowledge	Knowledge on measures for climate protection			
	General knowledge of scientific writing/working			
	General knowledge of scientific writing/working			
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
Knowledge	v/edge Students can describe urban development corridors as well as current and future urban environmental problems.			
	explain the causes of environmental problems (like noise).			
	Students can specify applications for various technical innovati	ons and explain why these contri	bute to the im	provement of urb
	life. They can, for example, derive and discuss measures for eff	ective noise abatement.		
Skille	Students are able to develop specific solutions for correc	ting existing or future environ	mont related	problems of ur
SKIIIS	development. They can define a range of conceptual and techn			
	paths. To solve specific urban environmental problems they c			
	context.			
Personal Competence				
•	The students can work together in international groups.			
·				
Autonomy	my Students are able to organize their work flow to prepare themselves for presentations and contributions to the disc			e discussions. Th
	can acquire appropriate knowledge by making enquiries indepe	ndently.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Written Report plus oral Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective	e Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elec	tive Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective C	Compulsory		
	Civil Engineering: Specialisation Water and Traffic: Elective Con	npulsory		
	Environmental Engineering: Core Qualification: Elective Compu	sory		
	Joint European Master in Environmental Studies - Cities and Sus	tainability: Core Qualification: Cor	mpulsory	
	Logistics, Infrastructure and Mobility: Specialisation Infrastructu	re and Mobility: Elective Compuls	ory	
	Water and Environmental Engineering: Specialisation Environm	ent: Elective Compulsory		
	Water and Environmental Engineering. Specialisation Environme	ent. Liective compuisory		

Course L1109: Noise Protection		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Martin Jäschke	
Language	EN	
Cycle	SoSe	
Content		
Literature	1) Müller & Möser (2013): Handbook of Engineering Acoustics (also available in German)	
	2) WHO (1999): Guidelines for Community Noise	
	3) Environmental Noise Directive 2002/49/EG	
	4) ISO 9613-2 (1996): Acoustics, Attenuation of sound during propagation outdoors, Part 2: General method of calculation	

Course L0874: Urban Infrast	urse L0874: Urban Infrastructures		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Lecturer	Dr. Dorothea Rechtenbach		
Language	EN		
Cycle	SoSe		
Content	Problem Based Learning		
	Main topics are:		
	Central vs. Decentral Wastewater Treatment.		
	Compaction of Cities.     Car Free Cities.		
	Multifunctional Places in Cities.		
	The Sustainability of Freight Transport in Cities.		
Literature	Depends on chosen topic.		

Courses				
Title		Тур	Hrs/wk	СР
Harbour Engineering (L0809)		Lecture	2	2
Harbour Engineering (L1414)		Project-/problem-based Learning	1	2
Port Planning and Port Construction	n (L0378)	Lecture	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of coastal engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follo	wing learning results		
Professional Competence				
Knowledge	The students are able to define in details and to choose desi	gn approaches for the functional c	lesign of a po	rt and apply ther
	design tasks. They can design the fundamental elements of a port.			
Chille	The students are able to calest and apply appropriate approach	has for the functional design of no	rta	
SKIIIS	The students are able to select and apply appropriate approac	thes for the functional design of po	rts.	
Personal Competence				
Social Competence	Social Competence The students are able to deploy their gained knowledge in applied problems such as the functional design of p		of ports. Addition	
	they will be able to work in team with engineers of other disci	olines.		
Autonomy	The students will be able to independently extend their knowledge	edge and apply it to new problems		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 150 min. The examination	on includes tasks with respect to	the general u	understanding of
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Electi	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Compulsory			
	Civil Engineering: Specialisation Water and Traffic: Elective Co	mpulsory		
	International Management and Engineering: Specialisation II.	Civil Engineering, Elective Compute		

Course L0809: Harbour Engineering		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Peter Fröhle	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Fundamentals of harbor engineering <ul> <li>Maritime transportation and waterways engineering</li> <li>Ships</li> </ul> </li> <li>Elements of harbors <ul> <li>Harbor approaches and water-side harbor areas</li> <li>Terminal design and handling of cargo</li> <li>Quay-walls and piers</li> <li>Equipment of harbors</li> <li>Sluices and other special constructions</li> </ul> </li> <li>Connection to inland transportation / inland waterway transportation</li> <li>Protection of harbors <ul> <li>Breakwaters and Jetties</li> <li>Wave protection of harbors</li> </ul> </li> <li>Fishery and other small harbors</li> </ul>	
Literature	Brinkmann, B.: Seehäfen, Springer 2005	

## Module Manual M.Sc. "Civil Engineering"

ourse L1414: Harbour Engineering		
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Peter Fröhle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0378: Port Planning	and Port Construction		
Тур	ecture		
Hrs/wk			
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Frank Feindt		
Language	DE		
Cycle	SoSe		
Content	<ul> <li>Planning and implementation of major projects</li> <li>Market analysis and traffic relations</li> <li>Planning process and plan</li> <li>Port planning in urban neighborhood</li> <li>Development of the logistics center "Port of Hamburg" in the metropolis</li> <li>Quays and waterfront structure</li> <li>Special planning Law Harbor - securing of a flexible use of the port</li> <li>Dimensioning of quays</li> <li>Flood protection structures</li> <li>Port of Hamburg - Infrastructure and development</li> <li>Preparation of areas</li> <li>Scour formation in front of shore structures</li> </ul>		
Literature	Vorlesungsumdruck, s. www.tu-harburg.de/gbt		

Courses				
Title		Түр	Hrs/wk	СР
Hydraulic Models (L0813)		Project-/problem-based Learning	1	1
Modelling of Waves (L0812)		Project-/problem-based Learning	1	1
Modelling of Flow in Rivers and Est	Jaries (L0810)	Lecture	3	4
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>	Coastal Hydraulic Engineering I			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
<b>Professional Competence</b>				
Knowledge Students are able to define in detail the basic processes that are related to the modelling of flows		of flows in hy	ydraulic engineerir	
	Besides, they can describe the basic aspects of numerical m	odelling and actual numerical mod	lels for the sir	nulation of flows a
	waves.			
Skille	Students are able to apply hydrodynamic-numerical models t	practical hydraulic engineering ta	eke	
JKIIIS	Students are able to apply hydrodynamic-humencar models t	b practical hydraulic engineering ta	585.	
Personal Competence				
Social Competence	tence The students are able to deploy their gained knowledge in simple applied problems. Additionaly, they will be able to v		able to work in tea	
	with others.			
Autonomy	The students will be able to independently extend their know	edge and apply it to new problems		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 3 hours. The examination includes tasks with respect to the general understanding of t			
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elect	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: El	ective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective	Compulsory		
	Civil Engineering: Specialisation Computational Engineering:			

Course L0813: Hydraulic Models			
Тур	Project-/problem-based Learning		
Hrs/wk			
СР			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	DE/EN		
Cycle	SoSe		
Content	<ul> <li>Fundamentals of hydraulic models</li> <li>Model laws</li> <li>Pi theorem of Buckingham</li> <li>Practical examples of hydraulic models</li> </ul>		
Literature	Strobl, Zunic: Wasserbau, Kap. 11 Hydraulische Modelle, Springer		

Course L0812: Modelling of Waves			
Тур	oject-/problem-based Learning		
Hrs/wk			
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	DE/EN		
Cycle	SoSe		
Content	<ul> <li>Waves, interactions with shallow water and constructions</li> <li>Wave theories</li> <li>Sea state and surges</li> <li>Development of waves</li> <li>Wave spectra</li> <li>Modelling of Waves / phase averaged and phase resolved models</li> <li>Application of a phase averaged model for wave prediction (SWAN)</li> <li>Application of phase resolved wave models (Mike)</li> </ul>		
Literature	Vorlesungsumdruck		

<u> </u>	low in Rivers and Estuaries
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Edgar Nehlsen, Prof. Peter Fröhle
Language	EN
Cycle	SoSe
Content	Introduction to numerical flow modelling   Processes affecting tht flow  Examples and applications of numerical models  Procedure of numerical modelling  Model concept
	Basic equations of hydrodynamics  Saint-Venant equations Euler Equations Navier-Stokes equations Reynolds-averaged Navier-Stokes equations Shallow water equations
	Solving schemes  • Numerical discretization  • Solution algorithms  • Convergence
Literature	Vorlesungsskript
	Literaturempfehlungen Bund der Ingenieure für Wasserwirtschaft, Abfallwirtschaft und Kulturbau (1997): Hydraulische Berechnung von naturnahen Fließgewässern. Düsseldorf: BWK (BWK-Merkblatt). Chow, Ven-te (1959): Open-channel Hydraulics. New York usw.: McGraw-Hill (McGraw-Hill Civil Engineering Series). Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019a): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 1: Geodaten in der Fließgewässermodellierung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-1).
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019b): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 2: Bedarfsgerechte Datenerfassung und -aufbereitung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-2).
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019c): Merkblatt DWA-M 543-3 Geodaten in der Fließgewässermodellierung - Teil 3: Aspekte der Strömungsmodellierung und Fallbeispiele. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-3).
	Hervouet, Jean-Michel (2007): Hydrodynamics of free surface flows. Modelling with the finite element method. Chichester: Wiley Online verfügbar unter http://www.loc.gov/catdir/enhancements/fy0741/2007296953-b.html.
	IAHR (2015): Professional Specifications for Physical and Numerical Studies in Environmental Hydraulics. In: Hydrolink (3/2015), S 90-92.
	Olsen, Nils Reidar B. (2012): Numerical Modelling and Hydraulics. 3. Aufl. Department of Hydraulic and Environmental Engineering The Norwegian University of Science and Technology.
	Szymkiewicz, Romuald (2010): Numerical modeling in open channel hydraulics. Dordrecht: Springer (Water science and technology library, 83).
	van Waveren, Harold (1999-): Good modelling practice handbook. [Utrecht], Lelystad, Den Haag: STOWA; Rijkswaterstaat-RIZA SDU, afd. SEO/RIZA [etc. distr.] (Nota, nr. 99.036).
	Zielke, Werner (Hg.) (1999): Numerische Modelle von Flüssen, Seen und Küstengewässern. Deutscher Verband für Wasserwirtschaft und Kulturbau. Bonn: Wirtschafts- und VerlGes. Gas und Wasser (Schriftenreihe des Deutschen Verbandes für Wasserwirtschaft und Kulturbau, 127).

Module M0874: Wast	ewater Systems			
Courses				
Title		Тур	Hrs/wk	СР
Biological Wastewater Treatment (I		Lecture	2	2
Biological Wastewater Treatment (		Recitation Section (large	) 1 2	1
Advanced Wastewater Treatment ( Advanced Wastewater Treatment (		Lecture Recitation Section (large	-	2 1
			) 1	1
Module Responsible				
Admission Requirements	None			
	Knowledge of wastewater management	and the key processes involved in wastewater t	reatment.	
Knowledge				
	After taking part successfully, students I	nave reached the following learning results		
Professional Competence				
Knowledge		f the full range of treatment systems in waste v	-	
	dependence for sustainable water prote-	ction. They can describe relevant economic, env	ironmental and socia	factors.
Skills	Students are able to pre-design and ex	plain the available wastewater treatment proc	esses and the scone	of their application
SKIIS	municipal and for some industrial treatm			or their application
	indificipal and for some madstral clean	iene pianes.		
Personal Competence				
Social Competence	Social skills are not targeted in this module.			
Autonomy		a subject and to organize their work flow inde	ependently. They can	also present on t
	subject.			
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structur	al Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotech	nnical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Water a	nd Traffic: Compulsory		
	Bioprocess Engineering: Specialisation A	- General Bioprocess Engineering: Elective Con	pulsory	
	Environmental Engineering: Specialisation	on Water Quality and Water Engineering: Electiv	e Compulsory	
	International Management and Engineer	ing: Specialisation II. Process Engineering and B	iotechnology: Elective	e Compulsory
	International Management and Engineer	ing: Specialisation II. Energy and Environmental	Engineering: Elective	Compulsory
	Process Engineering: Specialisation Envi	ronmental Process Engineering: Elective Compu	lsory	
	Process Engineering: Specialisation Proc	ess Engineering: Elective Compulsory		
	Water and Environmental Engineering: S	Specialisation Water: Compulsory		
	Water and Environmental Engineering: S	Specialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: S	Specialisation Cities: Compulsory		

Course L0517: Biological Wastewater Treatment		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Joachim Behrendt	
Language	DE/EN	
Cycle	SoSe	
Content	Charaterisation of Wastewater	
	Metobolism of Microorganisms	
	Kinetic of mirobiotic processes	
	Calculation of bioreactor for wastewater treatment	
	Concepts of Wastewater treatment	
	Design of WWTP	
	Excursion to a WWTP	
	Biofilms	
	Biofim Reactors	
	Anaerobic Wastewater and sldge treatment	
	resources oriented sanitation technology	
	Future challenges of wastewater treatment	
Literature	Gujer, Willi	
	Siedlungswasserwirtschaft : mit 84 Tabellen	

ISBN: 3540343296 (Gb.) URL: http://www.gbv.de/dms/bs/toc/516261924.pdf URL: http://deposit.d-nb.de/cgi-bin/dokserv?
id=2842122&prov=M&dok_var=1&dok_ext=htm
Berlin [u.a.] : Springer, 2007
TUB_HH_Katalog
Henze, Mogens
Wastewater treatment : biological and chemical processes
ISBN: 3540422285 (Pp.)
Berlin [u.a.] : Springer, 2002
TUB_HH_Katalog
Imhoff, Karl (Imhoff, Klaus R.;)
Taschenbuch der Stadtentwässerung : mit 10 Tafeln
ISBN: 3486263331 ((Gb.))
München [u.a.] : Oldenbourg, 1999
TUB_HH_Katalog
Lange, Jörg (Otterpohl, Ralf; Steger-Hartmann, Thomas;)
Abwasser : Handbuch zu einer zukunftsfähigen Wasserwirtschaft
ISBN: 3980350215 (kart.) URL: http://www.gbv.de/du/services/agi/52567E5D44DA0809C12570220050BF25/000000700334
Donaueschingen-Pfohren : Mall-Beton-Verl., 2000
TUB_HH_Katalog
Mudrack, Klaus (Kunst, Sabine;)
Biologie der Abwasserreinigung : 18 Tabellen
ISBN: 382741427X URL: http://www.gbv.de/du/services/agi/94B581161B6EC747C1256E3F005A8143/420000114903
Heidelberg [u.a.] : Spektrum, Akad. Verl., 2003
TUB_HH_Katalog
Tchobanoglous, George (Metcalf & Eddy, Inc., ;)
Wastewater engineering : treatment and reuse
ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk))
Boston [u.a.] : McGraw-Hill, 2003
TUB_HH_Katalog
Henze, Mogens
Activated sludge models ASM1, ASM2, ASM2d and ASM3
ISBN: 1900222248
London : IWA Publ., 2002
TUB_HH_Katalog
Kunz, Peter
Umwelt-Bioverfahrenstechnik
Vieweg, 1992
Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung für
Wasserwirtschaft, Abwasser und Abfall, ;)
Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe
aus der Abwasserbehandlung, Kleinkläranlagen
ISBN: 3860682725 URL: http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf URL:
http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf
Weimar : Universitätsverl, 2006
TUB_HH_Katalog
Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall
DWA-Regelwerk
Hennef : DWA, 2004
TUB_HH_Katalog
Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;)
Fundamentals of biological wastewater treatment
ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm
Weinheim : WILEY-VCH, 2007
TUB_HH_Katalog

Course L3122: Biological Wa	urse L3122: Biological Wastewater Treatment		
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Dr. Joachim Behrendt		
Language	DE/EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0357: Advanced Wastewater Treatment		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Joachim Behrendt	
Language	EN	
Cycle	SoSe	
Content	Survey on advanced wastewater treatment	
	reuse of reclaimed municipal wastewater	
	Precipitation	
	Flocculation	
	Depth filtration	
	Membrane Processes	
	Activated carbon adsorption	
	Ozonation	
	"Advanced Oxidation Processes"	
	Disinfection	
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003	
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987	
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007	
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung,	
	Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006	
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003	

Course L0358: Advanced Wa	stewater Treatment
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Joachim Behrendt
Language	EN
Cycle	SoSe
Content	Aggregate organic compounds (sum parameters)
	Industrial wastewater
	Processes for industrial wastewater treatment
	Precipitation
	Flocculation
	Activated carbon adsorption
	Recalcitrant organic compounds
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003

Module M0922: City F	
Courses	
Гitle	Typ Hrs/wk CP
City Planning (L1066)	Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
<b>Recommended Previous</b>	for "Principles of Urban Planning": none
Knowledge	for "Designing Urban Streetscapes": some knowledge of transport planning, e.g. through taking the undergraduate class "Trans
	Planning and Traffic Engineering"
	After taking part successfully, students have reached the following learning results
	After taking part successfully, students have reached the following learning results
Professional Competence	Students are able to:
Kilowiedge	
	use technical terms of urban planning.
	describe the main determinants of urban development.
	<ul> <li>explain and compare different possibilities of how urban development can be influenced.</li> </ul>
	discuss requirements for public streetscapes.
	explain the importance of street design.
Skills	Students are able to:
	<ul> <li>read and analyze urban development concepts and designs for streetscapes</li> </ul>
	appraise such concepts in the context of competing requirements.
	<ul> <li>design, justify and reflect their own solutions for concrete examples.</li> </ul>
Personal Competence	
Social Competence	Students are able to:
	discuss intermediate results with each other.
	<ul> <li>constructively accept feedback on their own work.</li> </ul>
	<ul> <li>provide constructive feedback to others.</li> </ul>
Autonomy	Students are able to:
	<ul> <li>independently complete a written report including drawings following a broadly pre-defined process.</li> </ul>
	<ul> <li>assess the consequences of their proposed solutions.</li> </ul>
	<ul> <li>independently acquire knowledge and apply this to new issues or problem areas.</li> </ul>
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and scale	written assignment, designwork during the semester
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
-	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Compulsory

Courses				
Title	Тур		Hrs/wk	СР
Construction Logistics (L1163)	Lect		1	2
Construction Logistics (L1164)		tation Section (small)	1	2
Project Development and Managen		ure ect-/problem-based Learning	1	1
Project Development and Managen		ect-/problem-based Leanning	T	1
Module Responsible	-			
Admission Requirements Recommended Previous				
Kecommended Previous	none			
	After taking part successfully, students have reached the following lea	arning roculto		
Educational Objectives	After taking part successionly, students have reached the following lea			
Professional Competence	Students con			
Knowledge	Students can			
	• give definitions of the main terms of construction logistics and	project development and m	anagement	
	name advantages and disadvantages of internal or external co	nstruction logistics		
	• explain characteristics of products, demand and production of	construction objects and the	eir consequer	nces for constructio
	specific supply chains			
	differentiate constructions logistics from other logistics system	S		
Skille	Students can			
SKIIIS				
	<ul> <li>carry out project life cycle assessments</li> </ul>			
	<ul> <li>apply methods and instruments of construction logistics</li> </ul>			
	<ul> <li>apply methods and instruments of project development and ma</li> </ul>	anagement		
	<ul> <li>apply methods and instruments of conflict management</li> </ul>			
	<ul> <li>design supply and waste removal concepts for a construction p</li> </ul>	roject		
Personal Competence				
Social Competence	Students can			
boerar competence				
	<ul> <li>hold presentations in and for groups</li> </ul>			
	<ul> <li>apply methods of conflict solving skills in group work and case</li> </ul>	studies		
Autonomy	Students can			
, aconomy				
	<ul> <li>solve problems by holistic, systemic and flow oriented thinking</li> </ul>			
	<ul> <li>improve their creativity, negotiation skills, conflict and crises</li> </ul>	s solution skills by applying	methods of	moderation in cas
	studies			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination	Written elaboration			
	Two written papers with presentations			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Com	pulsory		
Following Curricula				
string curriculu	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Water and Traffic: Elective Compulso	•		
	International Management and Engineering: Specialisation II. Civil Eng		orv	
	International Management and Engineering: Specialisation II. Logistics			
	Logistics, Infrastructure and Mobility: Specialisation Production and Lo	aistics: Elective Compulsory	/	

e L1163: Construction	Lecture
Hrs/wk	
CP	
	Independent Study Time 46, Study Time in Lecture 14 Prof. Heike Flämig
Language	
Cycle Content	The lecture gives deeper insight how important logistics are as a competetive factor for construction projects and which issues are to be adressed. The following toppics are covered: • competetive factor logistics • the concept of systems, planning and coordination of logistics • the concept of systems, planning and coordination of logistics • material, equipment and reverse logistics • IT in construction logistics • elements of the planning model of construction logistics and their connections • flow oriented logistics systems for construction projects • logistics concepts for ready to use construction projects (especially procurement and waste removel logistics) • best practice examples (construction logistics Potsdamer Platz, recent case study of the region) Contents of the lecture are deepened in special exercises.
Literature	Flämig, Heike: Produktionslogistik in Stadtregionen. In: Forschungsverbund Ökologische Mobilität (Hrsg.) Forschungsbericht Bo 15.2. Wuppertal 2000. Krauss, Siri: Die Baulogistik in der schlüsselfertigen Ausführung, Bauwerk Verlag GmbH Berlin 2005. Lipsmeier, Klaus: Abfallkennzahlen für Neubauleistungen im Hochbau : Verlag Forum für Abfallwirtschaft und Altlasten, 2004. Schmidt, Norbert: Wettbewerbsfaktor Baulogistik. Neue Wertschöpfungspotenziale in der Baustoffversorgung. In: Klaus, Peter Edition Logistik. Band 6. Deutscher Verkehrs-Verlag. Hamburg 2003. Seemann, Y.F. (2007): Logistikkoordination als Organisationseinheit bei der Bauausführung Wissenschaftsverlag Mainz in Aachen, Aachen. (Mitteilungen aus dem Fachgebiet Baubetrieb und Bauwirtschaft (Hrsg. Kuhne, V.): Heft 20)

ourse L1164: Construction Logistics	
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1161: Project Devel	ourse L1161: Project Development and Management		
Тур	Lecture		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei		
Language	DE		
Cycle	SoSe		
Content	<ul> <li>Within the lecture, the main aspects of project development and management are tought:</li> <li>Terms and definitions of project management</li> <li>Advantages and disadvantages of different ways of project handling</li> <li>organization, information, coordination and documentation</li> <li>cost and fincance management in projects</li> <li>time- and capacity management in projects</li> <li>specific methods and instruments for successful team work</li> </ul>		
Literature	Contents of the lecture are deepened in special exercises. Projektmanagement-Fachmann. Band 1 und Band 2. RKW-Verlag, Eschborn, 2004.		

Course L1162: Project Devel	rse L1162: Project Development and Management		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Structural Dynamics (L1202)		Lecture	2	2
Structural Dynamics (L1203)		Recitation Section (large)	2	2
Fracture mechanics and fatigue in	steel structures (L0564)	Lecture	1	1
Fracture mechanics and fatigue in	steel structures (L0565)	Recitation Section (large)	1	1
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
<b>Recommended Previous</b>	Knowledge of linear structural analysis	of statically determinate and indeterminate struc	tures; Mechanics	I/II, Mathematics
Knowledge	Differential equations I			
Educational Objectives	After taking part successfully, students h	have reached the following learning results		
Professional Competence	······	······································		
	After successful completion of this more	dule, the student can explain the basic aspects of	dynamic effects o	on structures and t
	respective methods.			
Skills	After successful completion of this mo	odule, the students will be able to predict the re	sponse of mater	ial and structures
	dynamics loading using the appropriate	computational approaches and methods.		
Personal Competence				
Social Competence	Students can			
	<ul> <li>participate in subject-specific and</li> </ul>	l interdisciplinary discussions,		
	<ul> <li>defend their own work results in f</li> </ul>	front of others		
	<ul> <li>promote the scientific developme</li> </ul>	ent of colleagues		
	<ul> <li>Furthermore, they can give and a</li> </ul>	ccept professional constructive criticism		
Autonomy	Students are able to gain knowledge of	the subject area from given and other sources and	apply it to new pr	oblems Furthermo
Autonomy		rocess for problems in the area of Structural Analysis		obierns. Furthernio
Workload in Hours	Independent Study Time 96, Study Time	e in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	150 min			
scale				
-	Civil Engineering: Specialisation Structur	ral Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotech	hnical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Water a	and Traffic: Elective Compulsory		
	Civil Engineering: Specialisation Comput	tational Engineering: Elective Compulsory		

Course L1202: Structural Dy	namics	
Тур	Lecture	
Hrs/wk		
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>mechanical background of dynamics</li> <li>harmonic vibrations, damped and undamped free and forced vibrations</li> <li>frequency and time domain</li> <li>modelling aspects</li> <li>principle of d'Alembert</li> <li>systems with multiple degrees of freedom</li> <li>consistent and lumped mass matrices</li> <li>finite elements for dynamics problems</li> <li>impact problems</li> <li>eigenvalue problems and modal analysis</li> <li>direct time integration schemes, transient analyses</li> </ul>	
Literature	<ul> <li>Vorlesungsmanuskript</li> <li>Clough, R.W., Penzien, J.: Dynamics of Structures. 2. Aufl., McGraw-Hill, New York, 1993.</li> </ul>	

Course L1203: Structural Dy	ourse L1203: Structural Dynamics	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Jürgen Priebe
Language	DE
Cycle	SoSe
Content	<ul> <li>basics of fatigue stress and fatigue resistance and determination of fatigue strength,</li> </ul>
	determination and use of S-N-curves and classification of notch effects,
	set up of determination of fatigue strength under dynamic load using the accumulation formula by Palmgren-Miner,
	set up of determination of fatigue strength in different examples,
	<ul> <li>basics of construction and design regarding the problem of material fatigue,</li> </ul>
	basics of linear elastic fracture mechanics under static and dynamic load,
	determination of lifetime of steel construction based on linear elastic fracture mechanics in different examples.
Literature	Seeßelberg, C.; Kranbahnen - Bemessung und konstruktive Gestaltung; 3. Auflage; Bauwerk-Verlag; Berlin 2009
	• Kuhlmann, Dürr, Günther; Kranbahnen und Betriebsfestigkeit; in Stahlbau Kalender 2003; Verlag Ernst & Sohn; Berlin 2003
	Deutscher Stahlbau-Verband (Hrsg.); Stahlbau Handbuch Band 1 Teil B; 3. Auflage; Stahlbau-Verlagsgesellschaft; Köln 199
	Petersen, C.; Stahlbau; 3. überarb. und erw. Auflage; Vieweg-Verlag; Braunschweig 1993
	<ul> <li>DIN V ENV 1993-1-1: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 1-1: Allgemeine Bemessungsree</li> <li>Bemessungsregeln f         ür den Hochbau; 1993</li> </ul>
	• DIN V ENV 1993-6: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 6: Kranbahnen; 2001
	DIN-Fachbericht 126. Richtlinie zur Anwendung von DIN V ENV 1993-6; Nationales Anwendungsdokument (NAD); Berlin 20
	1

Course L0565: Fracture mechanics and fatigue in steel structures	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Jürgen Priebe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Гitle		Тур	Hrs/wk	СР
Steel Construction Project (L1206)		Project Seminar	4	6
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
<b>Recommended Previous</b>	Steel and Composite Structures			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	Students are able to prepare a part of the	he whole project and explain it to the others.		
Skills	Students can produce sketches and calculations of their part of the project. They are able to adjust their work in reaction			
	changing conditions resulting from othe	r participants of the project.		
Personal Competence				
Social Competence	Students can present their results to ot	her members of the group.		
	They have the ability to work for a broa	d agreement with respect to intergroup depend	dencies.	
	They can distribute and process tasks ir	ndependently.		
Autonomy	Students can handle their part of the pr	oject on their own resposibility-		
Workload in Hours	Independent Study Time 124, Study Tin	ne in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	approx. 15-20 pages (without appendix	)		
scale				
Assignment for the	Civil Engineering: Specialisation Geotec	hnical Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Coasta	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structu	ral Engineering: Compulsory		
	Civil Engineering: Specialisation Compu	tational Engineering: Elective Compulsory		

Course L1206: Steel Construction Project	
Тур	Project Seminar
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	Design of a big construction project (i.e skyscraper, large bridge, roof of a stadiuim) in small groups
Literature	Wird je nach Projekt individuell angegeben.

Courses					
Title		Тур	Hrs/wk	СР	
Marine Geotechnics (L0548)		Lecture	1	2	
Marine Geotechnics (L0549)	Undrewlie Engine grieg (11146)	Recitation Section (large)	2	2	
Steel Structures in Foundation and		Lecture	Z	Z	
Module Responsible Admission Requirements					
	Complete modules: Geotechnics I-III, Math	omatics LIII			
Kecommended Previous Knowledge	complete modules: Geotechnics I-III, Math				
Kilowiedge	Courses: Soil laboratory course				
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	The students get a deeper knowledge of steel and ground engineering as well as constructions knowledge concerning quay wa				
Furthermore, the students get all the necessary knowledge to design singular construction elements for shee		et pile walls and th			
	know how to choose the right construction elements depending on the influencing conditions.				
	Furthermore, the students are able to div				
Skills Furthermore, the students are able to dimension sheet pile wall construction regarding all construction elements with according to the influence of discrete structure of the state					
	suitable construction elements with respect to the influencing conditions, to design all kinds of sheet pile walls (wave sheet pil walls and combined sheet pile walls) and to dimension all construction elements and connections.				
	waits and combined sheet pile waits) and t		10115.		
Personal Competence					
Social Competence					
Autonomy	Students are able to assess their own stre	ngths and weaknesses and organize their time and	learning manage	ement based on th	
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	Civil Engineering: Specialisation Geotechn	ical Engineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal E	ngineering: Compulsory			
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory			
		5 5 7 7			

Course L0548: Marine Geote	chnics
Тур	Lecture
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	<ul> <li>Geotechnical investigation an description of the seabed</li> <li>Foundations of Offshore-Constructions</li> <li>cCliff erosion</li> <li>Sea dikes</li> <li>Port structures</li> <li>Flood protection structures</li> </ul>
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst &amp; Sohn, Berlin</li> </ul>

## Module Manual M.Sc. "Civil Engineering"

Course L0549: Marine Geote	irse L0549: Marine Geotechnics	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Jürgen Grabe	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1146: Steel Structur	Course L1146: Steel Structures in Foundation and Hydraulic Engineering	
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Frank Feindt	
Language	DE	
Cycle	SoSe	
Content	Design of a sheet pile wall, design of a combined sheet pile wall, piles, walings, connections, fatigue	
Literature	EAU 2012, EA-Pfähle, EAB	

Courses				
Title		Тур	Hrs/wk	СР
Water and Environment (L2754) Water and Environment (L2753)		Project-/problem-based Learning Lecture	3 3	3 3
	Deef Nime Chalum	Lecture	2	3
Module Responsible Admission Requirements				
		dralagy		
Kecommended Previous Knowledge	Basic knowledge in water and environmental research, Hy	arology		
	After taking part successfully, students have reached the	iollowing loorning results		
Professional Competence	After taking part successiony, students have reached the	onowing learning results		
•	Common research tools and techniques tegether with	the fundamental knowledge relevan	t to multi-co	alo and multi ph
KIIOWIEdge	Common research tools and techniques together with the fundamental knowledge relevant to multi-scale and multi-pha challenges present in water and environmental research will be discussed in this module. Both theory and application will			
	considered.	will be discussed in this module. Bo	our theory and	u application will
	considered.			
Skills	In addition to the fundamental knowledge, the students	will be exposed to several analytical,	experimental	and numerical to
	and techniques relevant to water and environmental rese	arch at different scales. This will prov	ide the stude	nts with an excell
	opportunity to improve their skills on multiple fronts which	will be useful in their future career.		
Personal Competence				
Social Competence	Developing teamwork and problem solving skills through F	Research-Based Teaching approaches v	will be at the o	ore of this modul
Autonomy	The students will be involved in writing individual repo	rts and presentation. This will contri	bute to the s	students' ability
,	willingness to work independently and responsibly.			,
	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
	Subject theoretical and practical work			
Examination duration and	Report and Presentation			
scale				
-	Civil Engineering: Specialisation Coastal Engineering: Elect			
Following Curricula	Civil Engineering: Specialisation Water and Traffic: Elective			
	Environmental Engineering: Specialisation Environment ar			
	Water and Environmental Engineering: Specialisation Citie			
	Water and Environmental Engineering: Specialisation Water			
	Water and Environmental Engineering: Specialisation Envi	ronment: Compulsory		

Course L2754: Water and En	Course L2754: Water and Environment	
Тур	Project-/problem-based Learning	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Dr. Salome Shokri-Kuehni	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L2753: Water and En	vironment
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	SoSe
Content	Research based learning: The students will be engaged in active research focused on water and environmental related challenges.
	The required knowledge and tools will be discussed during the semester.
Literature	NA

Courses		
Title Port Logistics (L0686)	TypHrs/wkCPLecture23	
Port Logistics (L1473)	Recitation Section (small) 2 3	
Module Responsible		
Admission Requirements		
Recommended Previous Knowledge		
Educational Objectives		
Professional Competence		
Knowledge		
	After completing the module, students can	
	<ul> <li>reflect on the development of seaports (in terms of the functions of the ports and the corresponding terminals, is relevant operator models) and place them in their historical context;</li> <li>explain and evaluate different types of seaport terminals and their specific characteristics (cargo, the technologies, logistic functional areas);</li> <li>analyze common planning tasks (e.g. berth planning, stowage planning, yard planning) at seaport terminals suitable approaches (in terms of methods and tools) to solve these planning tasks;</li> <li>identify future developments and trends regarding the planning and control of innovative seaport terminals them in a problem-oriented manner.</li> </ul>	transhipme and devel
Skills	<ul> <li>After completing the module, students will be able to</li> <li>recognize functional areas in ports and seaport terminals;</li> <li>define and evaluate suitable operating systems for container terminals;</li> <li>perform static calculations with regard to given boundary conditions, e.g. required capacity (parking spaces requirements, quay wall length, port access) on selected terminal types;</li> <li>reliably estimate which boundary conditions influence common logistics indicators in the static planning of select types and to what extent.</li> </ul>	
Personal Competence Social Competence	After completing the module, students can	
	<ul> <li>transfer the acquired knowledge to further questions of port logistics;</li> </ul>	
	<ul> <li>discuss and successfully organize extensive task packages in small groups;</li> </ul>	
	<ul> <li>in small groups, document work results in writing in an understandable form and present them to an appropriat</li> </ul>	e extent.
Autonomy	After completing the module, the students are able to	
	<ul> <li>research and select specialist literature, including standards, guidelines and journal papers, and to develop independently;</li> </ul>	
	<ul> <li>submit own parts in an extensive written elaboration in small groups in due time and to present them jointly w time frame.</li> </ul>	within a fix
	time frame.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Credit points		
Course achievement	Compulsory         Bonus         Form         Description           No         15 %         Written elaboration	
Examination	Written exam	
Examination duration and		
scale		
Assignment for the		
Following Curricula		
<b>3</b>	Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory	
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory	
	Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory	
	Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory	
	Theoretical Mechanical Engineering: Specialisation Maritime Technology: Elective Compulsory	

Course L0686: Port Logistics	
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Carlos Jahn
Language	DE
Cycle	SoSe
Content	Port Logistics deals with the planning, control, execution and monitoring of material flows and the associated information flows in the port system and its interfaces to numerous actors inside and outside the port area. The extraordinary role of maritime transport in international trade requires very efficient ports. These must meet numerous requirements in terms of economy, speed, safety and the environment. Against this background, the lecture Port Logistics deals with the planning, control, execution and monitoring of material flows and the associated information flows in the port system and its interfaces to numerous actors inside and outside the port area. The aim of the lecture Port Logistics is to convey an understanding of structures and processes in ports. The focus will be on different types of terminals, their characteristical layouts and the technical equipment used as well as the ongoing digitization and interaction of the players involved. In addition, renowned guest speakers from science and practice will be regularly invited to discuss some lecture-relevant topics from alternative perspectives. The following contents will be conveyed in the lectures: • Instruction of structures and processes in the port • Planning, control, implementation and monitoring of material and information flows in the port • Fundamentals of different terminals, characteristical layouts and the technical equipment used • Handling of current issues in port logistics
Literature	<ul> <li>Alderton, Patrick (2013). Port Management and Operations.</li> <li>Biebig, Peter and Althof, Wolfgang and Wagener, Norbert (2017). Seeverkehrswirtschaft: Kompendium.</li> <li>Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. Berlin Heidelberg: Springer-Verlag, 2005.</li> <li>Büter, Clemens (2013). Außenhandel: Grundlagen internationaler Handelsbeziehungen.</li> <li>Gleissner, Harald and Femerling, J. Christian (2012). Logistik: Grundlagen, Übungen, Fallbeispiele.</li> <li>Jahn, Carlos; Saxe, Sebastian (Hg.). Digitalization of Seaports - Visions of the Future, Stuttgart: Fraunhofer Verlag, 2017.</li> <li>Kummer, Sebastian (2019). Einführung in die Verkehrswirtschaft</li> <li>Lun, Y.H.V. and Lai, KH. and Cheng, T.C.E. (2010). Shipping and Logistics Management.</li> <li>Woitschützke, Claus-Peter (2013). Verkehrsgeografie.</li> </ul>

Course L1473: Port Logistics	
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Carlos Jahn
Language	DE
Cycle	SoSe
Content	The content of the exercise is the independent preparation of a scientific paper plus an accompanying presentation on a current topic of port logistics. The paper deals with current topics of port logistics. For example, the future challenges in sustainability and productivity of ports, the digital transformation of terminals and ports or the introduction of new regulations by the International Maritime Organization regarding the verified gross weight of containers. Due to the international orientation of the event, the paper is to be prepared in English.
Literature	<ul> <li>Alderton, Patrick (2013). Port Management and Operations.</li> <li>Biebig, Peter and Althof, Wolfgang and Wagener, Norbert (2017). Seeverkehrswirtschaft: Kompendium.</li> <li>Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. (2005) Berlin Heidelberg: Springer-Verlag.</li> <li>Büter, Clemens (2013). Außenhandel: Grundlagen internationaler Handelsbeziehungen.</li> <li>Gleissner, Harald and Femerling, J. Christian (2012). Logistik: Grundlagen, Übungen, Fallbeispiele.</li> <li>Jahn, Carlos; Saxe, Sebastian (Hg.) (2017) Digitalization of Seaports - Visions of the Future, Stuttgart: Fraunhofer Verlag.</li> <li>Kummer, Sebastian (2019). Einführung in die Verkehrswirtschaft</li> <li>Lun, Y.H.V. and Lai, KH. and Cheng, T.C.E. (2010). Shipping and Logistics Management.</li> <li>Woitschützke, Claus-Peter (2013). Verkehrsgeografie.</li> </ul>

Module M1845: Thin-	walled structures			
Courses				
Title		Тур	Hrs/wk	СР
Thin-walled structures (L1199)		Lecture	2	3
Thin-walled structures (L3045)		Recitation Section (lar	ge) 2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
<b>Recommended Previous</b>	<ul> <li>Structural Applysis I</li> </ul>			
Knowledge	Structural Analysis I			
	Structural Analysis II			
	Finite Element Methods			
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	After successful completion of this modu	le, the students can express the basic asp	ects of the load-carryi	ng behaviour of thin
	walled structures.			
Skills	After successful completion of this module	e, the students will be able to predict load	carrying behaviour of	thin-walled structure
	using appropriate analytical and coputation		, , ,	
Personal Competence				
Social Competence	Students can			
	<ul> <li>participate in subject-specific and in</li> </ul>	terdisciplinary discussions,		
	defend their own work results in from	nt of others		
	<ul> <li>promote the scientific development</li> </ul>	of colleagues		
	Furthermore, they can give and acc	•		
Autonomy	Students are able to gain knowledge of the			
	they are able to structure the solution proc	ess for problems in the area of modelling a	nd analysis of thin-walle	ed structures.
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Er	igineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechni	cal Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Computat	ional Engineering: Compulsory		
	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specia	alisation Simulation Technology: Elective Co	mpulsory	

Тур	Lecture
Hrs/wk	
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	Plates loaded in-plane
	<ul> <li>Governing equations (equilibrium, kinematics, constitutive law)</li> </ul>
	Differential equation
	Airy stress function
	Plane stress / plane strain
	Structural behaviour of plates loaded in-plane
	• finite elements for plates loaded in-plane, modelling apsects, interpretation and critical assessment of results
	Plates in bending
	Governing equations (equilibrium, kinematics, constitutive law)
	Differential equation
	Navier solution / Fourier series expansion
	Approximation procedures
	Circular and rectangular plates
	Structural behaviour of plates in bending
	<ul> <li>finite elements for plates in bending, modelling apsects, interpretation and critical assessment of results</li> </ul>
	Shells
	Jiens
	Phenomenona of the structural behaviour of shells
	Membrane and bending theory
	Equilibrium equations of shells of revolution
	Stress resultants and deformations of the spherical shell, the half spherical shell, and the cylindrical shell
	finite elements for shells
	Stability problems (overview)
	Plate buckling
	Shell buckling
	- Shen bucking
Literature	
Literature	Vorlesungsmanuskript
	Basar, Y.: Krätzig, W.B. (1985): Mechanik der Flächentragwerke. Vieweg-Verlag, Braunschweig, Wiesbaden
	Girkmann, K. (1963): Flächentragwerke, Springer Verlag, Wien, 1963, unveränderter Nachdruck 1986
	• Zienkiewicz, O.C. (1977): The Finite Element Method in Enginieering Science. McGraw-Hill, London

Course L3045: Thin-walled st	ourse L3045: Thin-walled structures	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Maritime Transport (L0063)		Lecture	2	3
Maritime Transport (L0064)		Recitation Section (small)	2	3
Module Responsible				
Admission Requirements	None			
Recommended Previous				
Knowledge				
	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	The students are able to			
	<ul> <li>present the actors involved in the maritime trans</li> </ul>	port chain with regard to their typical	tasks;	
	<ul> <li>name common cargo types in shipping and classi</li> </ul>	fy cargo to the corresponding categor	ies;	
	<ul> <li>explain operating forms in maritime shipping, tra</li> </ul>	nsport options and management in tra	ansport networks	;
	<ul> <li>weigh the advantages and disadvantages of the</li> </ul>	various modes of hinterland transport	and apply them i	n practice;
	<ul> <li>estimate the potential of digitisation in maritime</li> </ul>	shipping.		
Skills	The students are able to			
	<ul> <li>determine the mode of transport, actors and fund</li> </ul>	tions of the actors in the maritime su	oply chain:	
	<ul> <li>identify possible cost drivers in a transport chain</li> </ul>			on;
	<ul> <li>record, map and systematically analyse mater</li> </ul>			
	problems and recommend solutions;		3	
	<ul> <li>perform risk assessments of human disruptions to</li> </ul>	the supply chain;		
	<ul> <li>analyse accidents in the field of maritime logistic</li> </ul>	and evaluating their relevance in ev	eryday life;	
	<ul> <li>deal with current research topics in the field of m</li> </ul>	aritime logistics in a differentiated wa	y;	
	<ul> <li>plan the deployment of a fleet based on scenario</li> </ul>	5;		
	<ul> <li>apply different process modelling methods in a h</li> </ul>	therto unknown field of activity and to	o work out the re	spective advantag
Personal Competence				
	The students are able to			
	<ul> <li>discuss and organise extensive work packages in</li> </ul>	groups;		
	<ul> <li>document and present the elaborated results.</li> </ul>			
Autonomy	The students are capable to			
	<ul> <li>research and select technical literature, including</li> </ul>	standards and guidelines;		
	<ul> <li>submit own shares in an extensive written elabor</li> </ul>	ation in small groups in due time.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory Bonus Form Desc	iption		
	No 15 % Subject theoretical and Teilr	ahme an einem Planspiel und anschli	eßende schriftlich	ne Ausarbeitung
	practical work			
Examination	Written exam			
Examination duration and	120 minutes			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: El	ective Compulsory		
Following Curricula	International Management and Engineering: Specialisat			
-	Logistics, Infrastructure and Mobility: Specialisation Prod	• • •	sory	
	Logistics, Infrastructure and Mobility: Specialisation Infr			
	Renewable Energies: Specialisation Wind Energy System	s: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation Mari	ime Technology: Elective Compulsory	,	

Course L0063: Maritime Trar	isport
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Carlos Jahn
Language	DE
Cycle	SoSe
	The general tasks of maritime logistics include the planning, design, implementation and control of material and information flows in the logistics chain ship - port - hinterland. The aim of the course is to provide students with knowledge of maritime transport and the actors involved in the maritime transport chain. Typical problem areas and tasks will be dealt with, taking into account the economic development. Thus, classical problems as well as current developments and trends in the field of maritime logistics are considered. In the lecture, the components of the maritime logistics chain and the actors involved will be examined and risk assessments of human disturbances on the supply chain will be developed. In addition, students learn to estimate the potential of digitisation in maritime shipping, especially with regard to the monitoring of ships. In addition, students are able to design operational planning for fleets of container or tramp vessels. Further content of the lecture is the different modes of transport in the hinterland, which students can evaluate after completion of the course regarding their advantages and disadvantages.
Literature	<ul> <li>Clausen, Uwe and Geiger, Christiane. Verkehrs- und Transportlogistik. Berlin Heidelberg: Springer-Verlag, 2013.</li> <li>Schönknecht, Axel. Maritime Containerlogistik: Leistungsvergleich von Containerschiffen in intermodalen Transportketten. Berlin Heidelberg: Springer-Verlag, 2009.</li> <li>Rodrigue, Jean-Paul. Geography of Transport Systems. London New York: Routledge, 2020.</li> <li>Stopford, Martin. Maritime Economics Routledge, 2009.</li> </ul>

Course L0064: Maritime Trai	nsport
Тур	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Carlos Jahn
Language	DE
Cycle	SoSe
Content	The exercise lesson bases on the haptic management game MARITIME. MARITIME focuses on providing knowledge about structures and processes in a maritime transport network. Furthermore, the management game systematically provides process management methodology and also promotes personal skills of the participants.
Literature	<ul> <li>Brinkmann, Birgitt. Seehäfen: Planung und Entwurf. Berlin Heidelberg: Springer-Verlag, 2005.</li> <li>Koch Susanne. Methoden des Prozessmanagements. In: Einführung in das Management von Geschäftsprozessen. Springer, Berlin, Heidelberg, 2011.</li> <li>Liebetruth, Thomas. Prozessmanagement in Einkauf und Logistik, Springer Gabler: Wiesbaden, 2020.</li> <li>Schönknecht, Axel. Maritime Containerlogistik: Leistungsvergleich von Containerschiffen in intermodalen Transportketten. Berlin Heidelberg: Springer-Verlag, 2009.</li> <li>Stopford, Martin. Maritime Economics Routledge, 2009</li> </ul>

Courses				
Courses				
<b>Title</b> Smart Monitoring (L2762)		Typ Integrated Lecture	Hrs/wk	<b>CP</b> 2
Smart Monitoring (L2762) Smart Monitoring (L2763)		Recitation Section (small)	2	4
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
Recommended Previous	Basic knowledge or interest in object-oriented modeling	programming and sensor technologic	ogies are helpful	Interest in mor
Knowledge	research and teaching areas, such as Internet of Things			
-	skills of scientific working, are required. Basic knowledge			
	After taking part successfully, students have reached the	following loorning results		
	After taking part successfully, students have reached the	rollowing learning results		
Professional Competence	The students will become familiar with the principles of	nd practices of smart monitoring	The students wi	II ha abla ta da
Kilowiedye	The students will become familiar with the principles a decentralized smart systems to be applied for contin			
	environment. In addition, the students will learn to desig			
	analysis techniques, modern software design concepts, a also part of this module, which will be conducted throug			
	students will design smart monitoring systems that integr		-	•
	Specific focus will be put on the application of machine			
	real-world (built or natural) systems, such as bridges or s	- · ·		
	every group will be documented in a paper. All students of			
	system in the annual "Smart Monitoring" competition. The	5 1		
	will be taught in English. Limited enrollment.			J
Skills	The students will gain insights into operating state-of-the	-art smart sensor systems, used for	monitoring a wi	de range of phys
	processes relevant to engineering, such as environmental, structural, or comfort monitoring. The students will be capable			
	devising monitoring strategies of physical processes as part of group projects, tailored to their knowledge backgrounds, and			
	implement the strategies in smart wireless sensor nodes, using embedded computing and programming. Finally, the students w			
	be able to document the findings of their projects in short	reports.		
Personal Competence				
	The students will be able to work in groups, share parts	of the work for their projects, and de	evelop communio	ation skills, tow
	achieving the common project goals.			
Autonomy	The students will be able to gain a solid basis on appro		ineering, as well	as on documen
	results, through their involvement in their monitoring gro	up projects.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	10 pages of work with 15-minute oral presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective	e Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elec	1 9		
	Civil Engineering: Specialisation Structural Engineering: E			
	Computer Science: Specialisation II: Intelligence Engineer	• • •		
	Environmental Engineering: Specialisation Energy and Re			
	Environmental Engineering: Specialisation Environment a			
	Environmental Engineering: Specialisation Water Quality		pulsory	
	Mechatronics: Technical Complementary Course: Elective	Compulsory		
	Mechatronics: Core Qualification: Elective Compulsory			
	Theoretical Mechanical Engineering: Specialisation Robot		ompulsory	
	Water and Environmental Engineering: Specialisation Citie			
	Water and Environmental Engineering: Specialisation Env Water and Environmental Engineering: Specialisation Wat			

Course L2762: Smart Monito	ring
Тур	Integrated Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	SoSe
Content	In this course, principles of smart monitoring will be taught, focusing on modern concepts of data acquisition, data storage, and data analysis. Also, fundamentals of intelligent sensors and embedded computing will be illuminated. Autonomous software and decentralized data processing are further crucial parts of the course, including concepts of the Internet of Things, Industry 4.0 and cyber-physical systems. Furthermore, measuring principles, data acquisition systems, data management and data analysis algorithms will be discussed. Besides the theoretical background, numerous practical examples will be shown to demonstrate how smart monitoring may advantageously be used for assessing the condition of systems in the built or natural environment.
Literature	The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course. However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online.

Course L2763: Smart Monitor	ring
Тур	Recitation Section (small)
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	SoSe
	The contents of the exercises are based on the lecture contents. In addition to the exercises, project work will be conducted throughout the semester, which will consume the majority of the workload. As part of the project work, students will design smart monitoring systems that will be tested in the laboratory or in the field. As mentioned in the module description, the students will participate in the "Smart Monitoring" competition, hosted annually by the Institute of Digital and Autonomous Construction. Students are encouraged to contribute their own ideas. The tools required to implement the smart monitoring systems will be taught in the group exercises as well as through external sources, such as video tutorials and literature. The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course. However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online.

Courses					
Title		Trees	Hare built	СР	
Offshore Geotechnical Engineering	(10067)	<b>Typ</b> Lecture	Hrs/wk	1	
Hydro Power Use (L0013)		Lecture	1	1	
Wind Turbine Plants (L0011)		Lecture	2	3	
Nind Energy Use - Focus Offshore	L0012)	Lecture	1	1	
Module Responsible	Dr. Marvin Scherzinger				
Admission Requirements	None				
<b>Recommended Previous</b>	Module: Technical Thermodynamics I,				
Knowledge					
	Module: Technical Thermodynamics II,				
	Module: Fundamentals of Fluid Mechanics				
Educational Objectives	After taking part successfully, students have reached	the following learning results			
Professional Competence					
Knowledge	By ending this module students can explain in deta	I knowledge of wind turbines w	ith a particular focus o	f wind energy us	
	offshore conditions and can critical comment these a	offshore conditions and can critical comment these aspects in consideration of current developments. Furthermore, they are abl			
	to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic procedure				
	in the implementation of renewable energy projects in countries outside Europe.				
	Through active discussions of various topics within the seminar of the module, students improve their understanding and the				
	application of the theoretical background and are thus able to transfer what they have learned in practice.				
Skills	s Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate a				
	assess technically the resulting relationships in the c				
	compare critically the special procedure for the imple			tside Europe with	
	in principle applied approach in Europe and can apply	this procedure on exemplary the	eoretical projects.		
Personal Competence					
Social Competence	Students can discuss scientific tasks subjet-specificly	and multidisciplinary within a se	eminar.		
Autonomy	. Students can independently evaluit courses in the context of the emphasis of the lecture material to clear the contexts of t				
Autonomy	Students can independently exploit sources in the context of the emphasis of the lecture material to clear the contents of the lecture and to acquire the particular knowledge about the subject area.				
	rectare and to acquire the particular knowledge about	the subject area.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 7	0			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	180 min				
scale					
-	Civil Engineering: Specialisation Structural Engineerin				
Following Curricula	Civil Engineering: Specialisation Geotechnical Enginee				
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory				
	International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory				
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory				
	Product Development, Materials and Production: Spec				
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory				
	Renewable Energies: Core Qualification: Compulsory	aray Systems, Elective Commission	201		
	Theoretical Mechanical Engineering: Specialisation En Process Engineering: Specialisation Environmental Pro				
			Juisol y		
	Water and Environmental Engineering: Specialisation Water and Environmental Engineering: Specialisation		ry.		
	Water and Environmental Engineering: Specialisation Water and Environmental Engineering: Specialisation		' <b>y</b>		

ourse L0067: Offshore Geot	echnical Engineering		
Тур	ecture		
Hrs/wk			
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Dr. Jan Dührkop		
Language	DE		
Cycle	SoSe		
Content	<ul> <li>Overview and Introduction Offshore Geotechnics</li> <li>Introduction to Soil Mechanics</li> <li>Offshore soil investigation</li> <li>Focus on cyclical effects</li> <li>Geotechnical design of offshore foundations</li> <li>Monopiles</li> <li>Jackets</li> <li>Heavyweight foundations</li> <li>Geotechnical preliminary exploration for the use of lift boats and platforms</li> </ul>		
Literature	<ul> <li>Randolph, M. and Gourvenec, S (2011): Offshore Geotechnical Engineering. Spon Press.</li> <li>Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>BSH-Standard Baugrunderkundung für Offshore-Windenergieparks</li> <li>Lesny K. (2010): Foundations for Offshore Wind Turbines. VGE Verlag, Essen.</li> <li>EA-Pfähle (2012): Empfehlungen des Arbeitskreises Pfähle der DGGT. Ernst &amp; Sohn, Berlin.</li> </ul>		

Course L0013: Hydro Power	Use
Тур	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Achleitner
Language	DE
Cycle	SoSe
Content	<ul> <li>Introduction, importance of water power in the national and global context</li> <li>Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies</li> <li>Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems</li> <li>Construction of hydroelectric power plants: description of the individual components and their technical system interaction</li> <li>Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc.</li> <li>Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection</li> <li>Hydropower and the Environment</li> <li>Examples from practice</li> </ul>
Literature	<ul> <li>Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage</li> <li>Quaschning, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage</li> <li>Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage</li> <li>von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage</li> <li>Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006</li> </ul>

Course L0011: Wind Turbine	Plants	
Тур	ecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Rudolf Zellermann	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Historical development</li> <li>Wind: origins, geographic and temporal distribution, locations</li> <li>Power coefficient, rotor thrust</li> <li>Aerodynamics of the rotor</li> <li>Operating performance</li> <li>Power limitation, partial load, pitch and stall control</li> <li>Plant selection, yield prediction, economy</li> <li>Excursion</li> </ul>	
Literature	Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005	

Course L0012: Wind Energy	Use - Focus Offshore
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Skiba
Language	DE
Cycle	SoSe
Content	<ul> <li>Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering</li> <li>Physical fundamentals for utilization of wind energy</li> <li>Design and operation of offshore wind turbines, presentation of different concepts of offshore wind turbines, representation of the individual system components and their system-technical relationships</li> <li>Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures</li> <li>Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection</li> <li>Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics</li> <li>Development and planning of offshore wind farms</li> <li>Operation and optimization of offshore wind farms</li> <li>Day excursion</li> </ul>
Literature	<ul> <li>Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage</li> <li>Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidel-berg, 1997, 3. Auflage</li> <li>Hau, E.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage</li> <li>Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage</li> <li>Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage</li> </ul>

Module M0858: Coast	tal Hydraulic Engineering I			
Courses				
Title		Тур	Hrs/wk	СР
Basics of Coastal Engineering (L08		Lecture	3	4
Basics of Coastal Engineering (L14		Project-/problem-based Learnin	g 1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of hydraulic engineering, hydrolog	y and hydromechanics		
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	The students are able to define and expla	ain the basic concepts of coastal engineering and por	t engineering. Tl	hey are able to app
	the concepts to selected practical proble	ms of coastal engineering. Students can define and	determine the b	basics for design a
	dimensioning of coastal engineering cons	tructions.		
Skills	The students are canable to apply basic d	design approaches to selected and pre-defined desigr	tasks in coasta	Lengineering
SKIIIS	The students are capable to apply basic o	action approaches to selected and pre-defined design		rengineering.
Personal Competence				
Social Competence	The students are able to deploy their ga	ined knowledge in applied problems such as the de	sign of coastal p	protection structure
	Additionaly, they will be able to work in te	eam with engineers of other disciplines, for instance of	designing of coas	stal breakwaters.
Autonomy	The students will be able to independently	y extend their knowledge and applyit to new problem	15.	
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 2 ho	ours. The examination includes tasks with respect	to the general u	understanding of th
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Coastal E	Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechr	nical Engineering: Compulsory		
	Civil Engineering: Specialisation Structura	al Engineering: Elective Compulsory		
	Environmental Engineering: Specialisation	n Environment and Climate: Elective Compulsory		
	Environmental Engineering: Specialisation	n Water Quality and Water Engineering: Elective Com	pulsory	
	International Management and Engineering	ng: Specialisation II. Civil Engineering: Elective Comp	ulsory	
	Water and Environmental Engineering: Sp	pecialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Sp	pecialisation Water: Elective Compulsory		

Course L0807: Basics of Coastal Engineering			
Тур	Lecture		
Hrs/wk			
СР			
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
Lecturer	Prof. Peter Fröhle		
Language	EN		
Cycle	SoSe		
Content			
	Basics of planning and design     Water levels		
	Currents		
	Waves		
	∘ lce		
	Planning and Design in Coastal Engineering		
	Functional and constructional design		
	<ul> <li>Determination of design parameters</li> </ul>		
	Design-approaches		
	Filter		
	<ul> <li>Rubble mound constructions</li> </ul>		
	Piles		
	<ul> <li>Vertical constructions</li> </ul>		
Literature	Coastal Engineering Manual, CEM		
	Vorlesungsumdruck		

Course L1413: Basics of Coas	irse L1413: Basics of Coastal Engineering		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Water Protection and Wastewater I	-	Lecture	3	3
Water Protection and Wastewater I	-	Project Seminar	3	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	<ul> <li>Basic knowledge in water management;</li> </ul>			
Knowledge	<ul> <li>Good knowledge in urban drainage;</li> </ul>			
	<ul> <li>Good knowledge of wastewater treatme</li> </ul>	nt techniques;		
	<ul> <li>Good knowledge of pollutants (e.g. COD</li> </ul>	, BOD, TS, N, P) and their properties;		
Educational Objectives	After taking part successfully, students have re	pached the following learning results		
Professional Competence	Arter taking part successionly, students have re			
•	The students can describe the basic principles	of the regulatory framework related to th	e international and Eu	Iropean water secto
	They can explain limnological processes, sub			
	problems related to water protection, such as			
	solutions, remediation measures as well as cor	ceptual approaches.		
Cl://-			least sentent. Then	
SKIIIS	Students can accurately assess current proble actions to contribute to the planning of tom			
	administrative and legislative solutions to solve		they can suggest a	ppropriate technica
	administrative and regislative solutions to solve	e triese problems.		
Personal Competence				
Social Competence	The students can work together in internationa	l groups.		
Autonomv	Students are able to organize their work flow	to prepare presentations and discussions	. They can acquire ap	propriate knowledg
	by making enquiries independently.			
Workload in Hours	Independent Study Time 96, Study Time in Lec	ture 84		
Credit points	6			
Course achievement	None			
Examination				
	Term paper plus presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Eng	ineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical I	• • •		
-	Civil Engineering: Specialisation Coastal Engine	eering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Tra	ffic: Elective Compulsory		
	Environmental Engineering: Specialisation Wat	er Quality and Water Engineering: Elective	e Compulsory	
	International Management and Engineering: Sp	pecialisation II. Civil Engineering: Elective	Compulsory	
	Water and Environmental Engineering: Special	isation Cities: Elective Compulsory		
	Water and Environmental Engineering: Special	isation Water: Elective Compulsory		
	Water and Environmental Engineering: Special	isation Environment: Compulsory		

Course L0226: Water Protect	tion and Wastewater Management
Тур	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	<ul> <li>The lecture focusses on:</li> <li>Regulatory Framework (e.g. WFD)</li> <li>Main instruments for the water management and protection</li> <li>In depth knowledge of relevant measures of water pollution control</li> <li>Urban drainage, treatment options in different regions on the world</li> <li>Rainwater management, improved management of heavy rainfalls, downpours, rainwater harvesting, rainwater infiltration</li> <li>Case Studies and Field Trips</li> </ul>
Literature	<ul> <li>The literature listed below is available in the library of the TUHH.</li> <li>Water and wastewater technology Hammer, M. J. 1., &amp; . (2012). (7. ed., internat. ed.). Boston [u.a.]: Pearson Education International.</li> <li>Water and wastewater engineering : design principles and practice: Davis, M. L. 1. (2011) New York, NY: McGraw-Hill.</li> <li>Biological wastewater treatment: (2011). C. P. Leslie Grady, Jr. (3. ed.). London, Boca Raton, Fla. [u.a.]: IWA Publ.</li> </ul>

Course L2008: Water Protection and Wastewater Management	
Тур	Project Seminar
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	
Literature	

Courses				
Title		Тур	Hrs/wk	СР
Examination of Materials, Structura	-	Lecture	3	4
Examination of Materials, Structura		Recitation Section (small)	1	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge about building materials or m	aterial science, for example by the mod	ule Building Ma	terials and Buildin
Knowledge	Chemistry.			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	The students are able to describe the rules for tra- methods for the testing of building material proper testing methods.			
Skills	The students are able to responsibly discover the r They are able to chose suitable methods for the te the examination of the structural conditions of buil are able to describe an examination in form of a te	sting and inspection of construction produc dings. They are able to conclude from sym	ts, the examina	÷
Personal Competence Social Competence	The students can describe the different roles of m framework of material testing. They can describe t	• •	-	on bodies within th
Autonomy				stansive field
	Independent Study Time 124, Study Time in Lectur		cuge of a very c	Atensive neid.
Credit points				
Course achievement				
	Written exam			
Examination duration and				
scale				
	Civil Engineering: Specialisation Structural Enginee	ring: Elective Compulsory		
Following Curricula				
<b>J</b>	Civil Engineering: Specialisation Coastal Engineering			
	Civil Engineering: Specialisation Water and Traffic:			
	International Management and Engineering: Specia		ulsory	
	Materials Science and Engineering: Specialisation E		-	
	Materials Science: Specialisation Engineering Mate	rials: Elective Compulsory		

Course L0260: Examination of Materials, Structural Condition and Damages		
Тур	Lecture	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	WiSe	
Content	Materials testing and marking process of construction products, testing methods for building materials and structures, testing	
	reports and expert opinions, describing the condition of a structure, from symptons to the cause of damages	
Literature	Frank Schmidt-Döhl: Materialprüfung im Bauwesen. Fraunhofer irb-Verlag, Stuttgart, 2013.	

Course L0261: Examination of Materials, Structural Condition and Damages		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses						
Гitle			Тур		Hrs/wk	СР
Concrete Structures (L0579)			Seminar		1	1
Structural Concrete Members (L05	77)		Lecture		2	3
Structural Concrete Members (L05	78)		Recitation	n Section (large)	2	2
Module Responsible	NN					
Admission Requirements	None					
<b>Recommended Previous</b>	Recommended Previous Basics of structural analysis, conception and dimensioning of structural concrete					
Knowledge						
	Modules: Reinforced	d Concrete Structures I	+II, Structural Analysis I+II, Mec	hanics I+II		
Educational Objectives	After taking part su	ccessfully students ha	ve reached the following learnin	a results		
Professional Competence	The taking part sa	ceessiany, stadents na	ve rederied the following learnin	gresults		
	The students broad	on their skills in struct	ral engineering especially in th	e field of buildings	(houses roofs h	alls) They dispose
Knowledge	The students broaden their skills in structural engineering, especially in the field of buildings (houses, roofs, halls). They dispose the knowledge for the conception and design of concrete buildings and structural members that are often used.					
	the knowledge for th	ne conception and des	ight of concrete buildings and st		fat are often aset	
Skills	The students are ab	ble to apply procedure	s of the conception and dimens	ioning to to practica	al problems of st	ructural engineeri
	They are capable to draft concrete buildings and to design them for general action effects and to plan their detailin					
	They are capable	to arane conterete ban	dings and to design them for	general action effe	ects and to plan	their detailing a
			dings and to design them for In and construction sketches and			their detailing a
						their detailing a
Personal Competence	execution. Moreove	r, they can make desig	n and construction sketches and			their detailing a
-	execution. Moreove	r, they can make desig				their detailing a
Social Competence	execution. Moreove	r, they can make designler, they can make designler	in and construction sketches and high quality in teamwork.	d draw up technical	descriptions.	
Social Competence	execution. Moreove	r, they can make designler, they can make designler	n and construction sketches and	d draw up technical	descriptions.	
Social Competence Autonomy	execution. Moreove The students are ab The students are ab	r, they can make designler, they can make designler	in and construction sketches and high quality in teamwork. x conception and dimensioning t	d draw up technical	descriptions.	
Social Competence Autonomy	execution. Moreove The students are ab The students are ab Independent Study	r, they can make designle to obtain results of ole to carry out comple	in and construction sketches and high quality in teamwork. x conception and dimensioning t	d draw up technical	descriptions.	
Social Competence Autonomy Workload in Hours	execution. Moreove The students are ab The students are ab Independent Study 6 Compulsory Bonus	r, they can make designed ole to obtain results of ole to carry out comple Time 110, Study Time Form	in and construction sketches and high quality in teamwork. x conception and dimensioning to in Lecture 70 Description	d draw up technical	descriptions.	
Social Competence Autonomy Workload in Hours Credit points	execution. Moreove The students are ab The students are ab Independent Study 6	r, they can make designed ole to obtain results of ole to carry out comple Time 110, Study Time	in and construction sketches and high quality in teamwork. x conception and dimensioning t in Lecture 70	d draw up technical	descriptions.	
Social Competence Autonomy Workload in Hours Credit points	execution. Moreove The students are ab The students are ab Independent Study 6 Compulsory Bonus No None	r, they can make designed ole to obtain results of ole to carry out comple Time 110, Study Time Form	in and construction sketches and high quality in teamwork. x conception and dimensioning to in Lecture 70 Description	d draw up technical	descriptions.	
Social Competence Autonomy Workload in Hours Credit points Course achievement	execution. Moreove The students are ab The students are ab Independent Study 6 Compulsory Bonus No None Written exam	r, they can make designed ole to obtain results of ole to carry out comple Time 110, Study Time Form	in and construction sketches and high quality in teamwork. x conception and dimensioning to in Lecture 70 Description	d draw up technical	descriptions.	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination	execution. Moreove The students are ab The students are ab Independent Study 6 Compulsory Bonus No None Written exam	r, they can make designed ole to obtain results of ole to carry out comple Time 110, Study Time Form	in and construction sketches and high quality in teamwork. x conception and dimensioning to in Lecture 70 Description	d draw up technical	descriptions.	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale	execution. Moreove The students are ab The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes	r, they can make designed ole to obtain results of ole to carry out comple Time 110, Study Time <b>Form</b> Presentation	in and construction sketches and high quality in teamwork. x conception and dimensioning to in Lecture 70 Description	d draw up technical	descriptions.	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	execution. Moreove The students are ab The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp	r, they can make designed ole to obtain results of ole to carry out comple Time 110, Study Time Form Presentation	in and construction sketches and high quality in teamwork. x conception and dimensioning to in Lecture 70 Description Es werden 2 Referate a	d draw up technical	descriptions.	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	execution. Moreove The students are ab The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp	r, they can make designed ole to obtain results of ole to carry out comple Time 110, Study Time Form Presentation pecialisation Structura pecialisation Geotechn	in and construction sketches and high quality in teamwork. x conception and dimensioning in in Lecture 70 Description Es werden 2 Referate a Engineering: Compulsory	d draw up technical asks of structures u nusgegeben	descriptions.	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	execution. Moreove The students are ab The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: SI Civil Engineering: SI Civil Engineering: SI	r, they can make designed ole to obtain results of ole to carry out comple Time 110, Study Time Form Presentation pecialisation Structura pecialisation Geotechn pecialisation Coastal E	in and construction sketches and high quality in teamwork. x conception and dimensioning in in Lecture 70 Description Es werden 2 Referate a Engineering: Compulsory ical Engineering: Elective Comp	d draw up technical asks of structures u nusgegeben	descriptions.	
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	execution. Moreover The students are ab The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: SI Civil Engineering: SI Civil Engineering: SI Civil Engineering: SI	r, they can make designed ole to obtain results of ole to carry out comple Time 110, Study Time Form Presentation pecialisation Structura pecialisation Geotechn pecialisation Coastal E pecialisation Water and	in and construction sketches and high quality in teamwork. x conception and dimensioning in in Lecture 70 Description Es werden 2 Referate a Engineering: Compulsory ical Engineering: Elective Compulsory ngineering: Elective Compulsory	d draw up technical asks of structures u ausgegeben	descriptions.	

Course L0579: Concrete Stru	ictures
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	NN
Language	DE
Cycle	WiSe
Content	With help of a project teamwork the subjects of the course "Concrete Structures" is practiced, discussed and presented.
Literature	- Projektbezogene Unterlagen werden abgegeben.

Course L0578: Structural Concrete Members		
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	NN	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title	Тур		Hrs/wk	СР
Integrated Transportation Planning		problem-based Learning	4	6
Module Responsible	Prof. Carsten Gertz			
Admission Requirements				
<b>Recommended Previous</b>	some knowledge of transport planning, e.g. through taking the undergrad	luate class "Transport P	lanning and T	raffic Engineerin
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning	ng results		
Professional Competence				
Knowledge	Students are able to:			
	describe interdependencies between land-use/location choice and	transportation/mobility	hehaviour	
	<ul> <li>explain and evaluate the social, ecological and economic effects of</li> </ul>			ires
	<ul> <li>relate current issues in the area of integrated transport planning and</li> </ul>			
	· · · · · · · · · · · · · · · · · · ·			
Skills	Students are able to:			
		and influenced by th		
	<ul> <li>quantify important parameters, which influence travel demand or a</li> <li>comprehensively examine a pre-defined or self-selected topic from</li> </ul>		os porspostiv	a and document t
	results in accordance with scientific conventions.		es perspectiv	
Personal Competence				
-	Students are able to:			
,				
	<ul> <li>provide feedback on topical contents and their teaching.</li> </ul>			
	<ul> <li>constructively handle feedback on their own work.</li> <li>produce results in group work and decument these</li> </ul>			
	<ul> <li>produce results in group work and document these.</li> </ul>			
Autonomy	Students are able to:			
	<ul> <li>assess potential consequences of their future professional activitie</li> </ul>	S		
	<ul> <li>independently plan working on a pre-defined project topic, acquire</li> </ul>		ge and use a	ppropriate means
	its execution.	,,	5	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination	Written elaboration			
Examination duration and	written assignment with presentation during the semester			
scale	where assignment was presentation during the semester			
	Civil Engineering: Specialisation Structural Engineering: Elective Compuls	ory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Comp	•		
-	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsor	y		
	Civil Engineering: Specialisation Water and Traffic: Compulsory			
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mo	bility: Elective Compuls	ory	
	Water and Environmental Engineering: Specialisation Cities: Compulsory			

Course L1068: Integrated Tr	ansportation Planning
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß
Language	DE
Cycle	WiSe
	The course will provide students with an understanding of interdependencies between land-use and transportation. Specific topics include a.o.:    interactions between transport and the environment and consequent limitations  characteristics of integrated planning  complex planning processes  interdependencies of location choice and mobility behaviour  transport and land-use policies  project on current issues in transportation studies
Literature	Kutter, Eckhard (2019) Stadtstruktur und Erreichbarkeit in der postfossilen Zukunft. Erich Schmidt Verlag. Berlin. Gies, Huber u. a. (Hrsg.) (93. Ergänzung 2022) Handbuch der kommunalen Verkehrsplanung. Herbert Wichmann Verlag. Berlin, Offenbach. (Loseblattsammlung mit kontinuierlichen Ergänzungen)

Module M0963: Steel	and Composite Structures			
Courses				
Title		Тур	Hrs/wk	СР
Steel and Composite Structures (L1	204)	Lecture	2	2
Steel and Composite Structures (L1		Recitation Section (large)	2	2
Steel Bridges (L1097)		Lecture	2	2
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of steel construction (i.e. Steel Structures I an	d II, BUBC)		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
	After successful completition, students can			
	describe the phenomenon of local buckling			
	explain warping torsion			
	illustrate the behaviour of composite structure			
	specify the principles in design of composite s			
	sketch the contructions of steel and composite	e bridges		
Skills	After successful participation students are able to			
	<ul> <li>check stiffened and unstiffened plated structu</li> </ul>	res		
	<ul> <li>recognize and verify warping tosion in strucure</li> </ul>	es		
	<ul> <li>design composite structures</li> </ul>			
	<ul> <li>design bridges and o perform the detailing</li> </ul>			
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	4		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering	ng: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine			
-	Civil Engineering: Specialisation Coastal Engineering			
	Civil Engineering: Specialisation Water and Traffic: El	ective Compulsory		
	Civil Engineering: Specialisation Computational Engir			
	International Management and Engineering: Specialis	sation II. Civil Engineering: Elective Com	oulsory	

Course L1204: Steel and Con	Course L1204: Steel and Composite Structures		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Marcus Rutner		
Language	DE		
Cycle	WiSe		
Content	<ul> <li>Local-buckling of plated structures</li> <li>Warping torsion</li> <li>Composite-girders, -columns, -slabs, -bridges</li> <li>Principles in composite constructions</li> <li>Bridge-design and -construction</li> </ul>		
Literature	Petersen, C.: Stahlbau, 4.Auflage 2013, Springer-Vieweg Verlag Minnert, J. Wagenknecht, G.: Verbundbau-Praxis - Berechnung und Konstruktion nach Eurocode 4, 2.Auflage 2013, Bauwerk Beuth Verlag		

ourse L1205: Steel and Composite Structures		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Marcus Rutner	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1097: Steel Bridges	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Yves Freundt
Language	
Cycle	
Content	Lecture Contents ,Steel Bridge Construction' DrIng. Jörg Ahlgrimm
	- From tendering and contracting to completion - the development of a steel bridge
	- Contents of a bridge static - structural details, examples of analysis in detail:
	-> effective width in regard to the longitudinal stiffeners
	-> Bearing point, bearing stiffener
	-> Crossbeam breakthrough, crossbeam reinforcement
	-> Analysis of the Rib-to-Floorbeam (RF) connection (web-tooth of the floorbeam between trapezoidal shaped Ribs)
	- Steel grades, -designation, testing methods and approval certificates
	- Nondestructive weld inspecting
	- Corrosion protection
	- Bridge bearing - types, format, function, dimensioning, installation
	- Expansion Joints
	- Oscillation of bridge hangers and cables - oscillation damper
	- Opening bridges- Detailed reviews to different assembling procedures and - implements
	- Selective damage events
	Requirements: Basic knowledge in the calculation, dimensioning, and construction of structural elements and joints of constructional steelwork
Literature	
	Herbert Schmidt, Ulrich Schulte, Rainer Zwätz, Lothar Bär:     Ausführung von Stahlbauten
	• Petersen, Christian: Stahlbau, Abschnitt Brückenbau
	<ul> <li>Ahlgrimm, J., Lohrer, I.: Erneuerung der Eisenbahnüberführung in Fulda-Horas über die Fulda, Stahlbau 74 (2005), Heft 2, S.</li> <li>114</li> </ul>

## Module M0969: Selected Topics in Civil Engineering

Courses				
Title		Тур	Hrs/wk	СР
Design of Composite Bridges (L3092)		Integrated Lecture	2	3
Analysis of Offshore Structures (L1	867)	Lecture	1	1
Energy Geotechnics (L3227)		Lecture	3	3
Solid Matter Process Technology fo	r Biomass (L0052)	Lecture	2	3
Forum I - Geotechnics and Constru	ction Management (L1634)	Seminar	1	1
Forum II - Geotechnics and Constru	iction Management (L1635)	Seminar	1	1
Timber Structures (L1151)		Seminar	2	2
Innovative Timber Construction (L2	(666)	Lecture	2	4
Glass Structures (L1152)		Lecture	2	2
Glass Structures (L1447)		Recitation Section (large)	1	1
Sustainable landfill design and ope	ration (L3270)	Integrated Lecture	3	3
Special Topics in Steel Design (L30	91)	Integrated Lecture	2	3
Special topics of civil engineering 1	LCP (L2378)		1	1
Special topics of civil engineering 2	2 LP (L2379)		2	2
Special topics of civil engineering 3	3 LP (L2380)		3	3
Structural Design (L2789)		Seminar	2	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge				
_	<ul> <li>Students are able to find their way through s</li> </ul>	selected special areas within civil and struc	tural engineering	
	<ul> <li>Students are able to explain basic models ar</li> </ul>	nd procedures in selected special areas of	civil and structura	al engineering.
	<ul> <li>Students are able to interrelate scientific and</li> </ul>	d technical knowledge.		
Skills				
	<ul> <li>Students are able to apply basic methods in</li> </ul>	selected areas of civil and structural engin	eering.	
Personal Competence				
Social Competence				
Autonomy	• Students can chose independently in which	fields they want to deepen their line with	dao and skills the	ough the election
	<ul> <li>Students can chose independently, in which</li> </ul>	i neius they want to deepen their knowle	uge and skills thi	ough the election
	courses.			
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the	Civil Engineering: Specialisation Structural Enginee	ring: Elective Compulsory		
Following Curricula		• • •		
	Civil Engineering: Specialisation Coastal Engineerin			
	Civil Engineering: Specialisation Water and Traffic:			
	Civil Engineering: Specialisation Computational Eng	gineering: Elective Compulsory		

Course L3092: Design of Composite Bridges	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	
Literature	

## Module Manual M.Sc. "Civil Engineering"

Course L1867: Analysis of Of	
Тур	Lecture
CP Workload in Hours	1 Independent Study Time 16, Study Time in Lecture 14
Examination Form	
Examination duration and	
scale	
Lecturer	Dr. Said Fawad Mohammadi
Language	DE/EN
Cycle	SoSe
Content	Topic 1: Types of Offshore Structures, Fixed and floating structures for Oil & Gas and Offshore Wind industry
	Topic 2: Wave Forces, Morisons equation
	Topic 3: Irregular Seastates, Power spectrum and application of FFT
	Topic 4: Additional Environmental Forces, wind spectra, current forces
	Topic 5: Linear-Time-Invariant Systems, response of an LTI-system in frequency domain
	Topic 6: Tubular Welded Connections, stress concentration factors, weld geometry
	Topic 7: Introduction to Fracture Mechanics, criteria for fracture initiation and crack growth
	Topic 8: Time and Frequency Domain Fatigue Analyses, rainflow counting, application of LTI-systems for frequency domain fatigue
	Topic 9: Offshore Installation and Exam, installation of structures, pile driving, pipe laying techniques
Literature	Chakrabarti, Handbook of Offshore Engineering, 2005
	Sarpkaya, Wave Forces on Offshore Structures, 2010
	Faltinsen, Sea Loads on Ships and Offshore Structures, 1998
	Sorensen, Basic Coastal Engineering, 2006
	Dowling, Mechanical Behavior of Materials, 2007
	Haibach, Betriebsfestigkeit, 2006
	Marshall, Design of Welded Tubular Connections, 1992
	Newland, Random vibrations, spectral and wavelet analysis, 1993

Course L3227: Energy Geotechnics		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Schriftliche Ausarbeitung (laut FPrO)	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Pauline Kaminski	
Language	DE/EN	
Cycle	WiSe	
Content	Energy geotechnics is a young field in geotechnical engineering with the aim of developing sustainable geotechnical solutions for future-oriented issues relating to the production, transport, operation, decommissioning, and waste utilisation of various energy sources. Examples of possible fields of activity in energy geotechnics include geothermal energy and thermally activated foundation components, foundations for onshore and offshore wind turbines, the decommissioning of mining facilities and the handling of waste products from fossil fuels such as tailings and the geological storage of CO2. Relevant soil mechanical processes in these applications include the thermo-hydro-mechanically coupled behaviour of soils, multiphase flow in porous media and partially saturated soils. The lecture gives an overview of various aspects of energy geotechnics and provides in-depth knowledge of the associated soil mechanical processes. In addition, CO2-scarce geotechnical applications are discussed and emission estimates as well as the optimisation of geotechnical structures according to sustainability aspects are addressed.	
Literature		

Course L0052: Solid Matter F	Process Technology for Biomass
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Prof. Werner Sitzmann
Language	DE
Cycle	SoSe
Content	The industrial application of unit operations as part of process engineering is explained by actual examples of solid biomass
	processes. Size reduction, transportation and dosing, drying and agglomeration of renewable resources are described as important
	unit operations when producing solid fuels and bioethanol, producing and refining edible oils, when making Btl - and WPC -
	products. Aspects of explosion protection and plant design complete the lecture.
Literature	Kaltschmitt M., Hartmann H. (Hrsg.): Energie aus Bioamsse, Springer Verlag, 2001, ISBN 3-540-64853-4
	Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz, Schriftenreihe Nachwachsende Rohstoffe,
	Fachagentur Nachwachsende Rohstoffe e.V. www.nachwachsende-rohstoffe.de
	Bockisch M.: Nahrungsfette und -öle, Ulmer Verlag, 1993, ISBN 380000158175

Course L1634: Forum I - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1635: Forum II - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1151: Timber Structures	
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and	90 min
scale	
Lecturer	Prof. Torsten Faber
Language	DE
Cycle	WiSe
Content	
Literature	

Course L2666: Innovative Timber Construction		
Тур	Lecture	
Hrs/wk	2	
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Examination Form	Schriftliche Ausarbeitung	
Examination duration and	45 Minuten	
scale		
Lecturer	Dr. Andreas Meisel	
Language	DE	
Cycle	WiSe	
Content		
Literature	- Blass, J.: "Ingenieurholzbau"	
	- Schickhofer, G.: "BSPhandbuch: Holz-Massivbauweise in Brettsperrholz"	
	- Informationsdienst Holz: div. Merkblätter und Broschüren	
	- Wallner-Novak M.: Brettsperrholz Bemessung, Band 1 und 2	
	- Gerner M.: "Fachwerk: Entwicklung, Instandsetzung, Neubau"	
	- Meisel, A.: "Historische Dachwerke: Beurteilung, realitätsnahe statische Analyse und Instandsetzung"	
	- Kempe K.: "Dokumentation Holzschädlinge"	
	- Huckfeldt T.: "Hausfäule- und Bauholzpilze"	

Course L1152: Glass Structures	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	DE
Cycle	WiSe
Content	Glass structures
	- Introduction of the material glass (production, refinement, material characteristic)
	- design of facades
	- facade types
	- static calculation of glazing
	- static calculation of facades
	- load bearing behavior of glazing (plate or membrane stiffness)
	- vertical / horizontal glazing with safety-related requirements
	- glass structures
	- fire safety of glass facades
	- construction physics of facades and glazing
Literature	

Course L1447: Glass Structures	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L3270: Sustainable la	andfill design and operation
Тур	Integrated Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Dr. Marco Ritzkowski
Language	EN
Cycle	SoSe
Content	The course introduces the development of modern waste resource management and demonstrates the importance of landfills in the context of recycling processes. Based on international (EU) and national legislation, the current landfill situation is presented and the future significance of landfills will be discussed. A central element of the course deals with the main transformation processes in the landfilled waste, the emission of gases and leachate, the long-term behaviour of landfills as well as aftercare and after-utilisation measures. Further focal points of the course are measures for the sustainable reduction of environmentally and climate-damaging emissions and aspects of landfill technology in an international context.
Literature	<ol> <li>Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105, Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305</li> <li>Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332</li> <li>Solid Waste Landfilling - Concepts, Processes, Technologies. Cossu, R. and Stegmann, R. (Eds.), ISBN: 978-0-12-818336-6</li> <li>PDF (Volltext) über TUB</li> </ol>

Course L3091: Special Topics in Steel Design	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner, Nikolay Lalkovski
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2378: Special topics of civil engineering 1CP	
Тур	
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2379: Special topics of civil engineering 2 LP	
Тур	
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2380: Special topics of civil engineering 3 LP		
Тур		
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Fachtheoretisch-fachpraktische Arbeit	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Dozenten des SD B	
Language	DE	
Cycle	WiSe/SoSe	
Content	The course occurs only if required. The content is defined at short notice.	
Literature	Die Literatur wird kurzfristig festgelegt.	

Course L2789: Structural Design		
Тур	Seminar	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	20 min	
scale		
Lecturer	Dr. Jan Mittelstädt	
Language	DE/EN	
Cycle	SoSe	
Content		
Literature	[1] Structure Systems by Heino Engel, Hantje Cantz, 3rd edition (Feb 2007), ISBN-10: 3775718761	
	Form and Force, Designing Efficient, Expressive Structures by Allan, E., Zalewski, W. et al, John Wiley and	
	Sons; 1st edition (Sept 2009), ISBN-10: 047017465X	
	[2] Peter Rice: An Engineer Imagines, ISBN-10 : 1849944237	
	[3] Konrad Wachsmann and the Grapevine Structure by C. Sumi et al., Park Books (Oct 2018), ISBN-10:	
	9783038601104	
	[4] Manual of Multi-Story Timber Construction by Hermann Kaufmann, Stefan Krotsch, Stefan Winter, DETAIL,	
	(June 2018), ISBN-10: 3955533948	
	[5] The Art of Structural Design: A Swiss Legacy by B. Billington, Princeton University Art Museum; First Edition	
	edition (Mar 2003), ISBN-10: 0300097867	
	[6] Structured Lineages: Learning from Japanese Structural Design by G. Nordenson et al, The Museum of	
	Modern Art (Jul 2019), ISBN-10: 1633450562	
	[7] The Structure: Works of Mahendra Raj by V. Mehta, R. Mehndiretta, A. Huber, Park Books (Oct 2015),	
	ISBN-10: 3038600253	

Courses		
Title	Typ Hrs/wk CP	
Module Responsible	Prof. Peter Fröhle	
Admission Requirements	None	
<b>Recommended Previous</b>	Subjects of the Port and Coastal Engineering specialisation.	
Knowledge		
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	e The students are able to demonstrate their detailed knowledge in the field of port and coastal engineering. They can exemplify state of technology and application and discuss critically in the context of actual problems and general conditions of science society.	
	The students can develop solving strategies and approaches for fundamental and practical problems in port and coas engineering. They may apply theory based procedures and integrate safety-related, ecological, ethical, and economic view poin of science and society.	
Skills	Scientific work techniques that are used can be described and critically reviewed. The students are able to independently select methods for the project work and to justify this choice. They can explain how the methods relate to the field of work and how the context of application has to be adjusted. General findings and furth developments may essentially be outlined.	
Personal Competence		
Social Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to th colleagues.	
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the giv deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedba from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology	
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0	
Credit points	6	
Course achievement	None	
Examination	Study work	
Examination duration and scale	The number of pages depends on the task.	
Assignment for the Following Curricula	Civil Engineering: Specialisation Coastal Engineering: Compulsory	

Courses				
Title		Τγρ	Hrs/wk	СР
Chemistry of Drinking Water Treatment (L0311)		Lecture	2	1
Chemistry of Drinking Water Treatment (L0312)		Recitation Section (large)	1	2
Water Resource Management (L04	02)	Lecture	2	2
Water Resource Management (L04)	3)	Recitation Section (small)	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
<b>Recommended Previous</b>	Knowledge of water management and the	key processes involved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
<b>Professional Competence</b>				
	water supply. They will understand relevant economic, environmental and social factors. Students will be able to explain ar outline the organisational structures of water companies. They will be able to explain the available water treatment processes ar the scope of their application.			
Skills	Students will be able to assess complex problems in drinking water production and establish solutions involving wat management and technical measures. They will be able to assess the evaluation methods that can be used for this. Students w be able to carry out chemical calculations for selected treatment processes and apply generally accepted technical rules ar standards to these processes.			
Personal Competence				
Social Competence	Working in a diverse group of specialists, students will be able to develop and document complex solutions for the manageme			
	and treatment of drinking water. They wi	ill be able to take an appropriate professional	position, for examp	ole representing ι
	interests. They will be able to develop join	t solutions in teams of diverse experts and prese	ent these solutions i	to others.
Autonomy	Students will be in a position to work on a	subject independently and present on this subje	ct.	
Workload in Hours	Independent Study Time 96, Study Time ir	Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (chemistry) + presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechn	ical Engineering: Elective Compulsory		
-	Civil Engineering: Specialisation Water and			
	Civil Engineering: Specialisation Coastal En			
	International Management and Engineerin	g: Specialisation II. Energy and Environmental E	ngineering: Elective	Compulsory
	Process Engineering: Specialisation Enviro	nmental Process Engineering: Elective Compulso	iry	
	Process Engineering: Specialisation Process	s Engineering: Elective Compulsory		
	Water and Environmental Engineering: Spo	ecialisation Water: Compulsory		
	Water and Environmental Engineering: Sp	ecialisation Environment: Elective Compulsory		

Course L0311: Chemistry of	Drinking Water Treatment
	Lecture
Hrs/wk	
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Klaus Johannsen
Language	DE
Cycle	WiSe
Content	The topic of this course is water chemistry with respect to drinking water treatment and water distribution
	Major topics are solubility of gases, carbonic acid system and calcium carbonate, blending, softening, redox processes, materials and legal requirements on drinking water treatment. Focus is put on generally accepted rules of technology (DVGW- and DIN- standards). Special emphasis is put on calculations using realistic analysis data (e.g. calculation of pH or calcium carbonate dissolution potential) in exercises. Students can get a feedback and gain extra points for exam by solving problems for homework. Knowledge of drinking water treatment processes is vital for this lecture. Therefore the most important processes are explained coordinated with the course " Water resources management" in the beginning of the semester.
Literature	<ul> <li>MHW (rev. by Crittenden, J. et al.): Water treatment principles and design. John Wiley &amp; Sons, Hoboken, 2005.</li> <li>Stumm, W., Morgan, J.J.: Aquatic chemistry. John Wiley &amp; Sons, New York, 1996.</li> <li>DVGW (Hrsg.): Wasseraufbereitung - Grundlagen und Verfahren. Oldenbourg Industrie Verlag, München, 2004.</li> <li>Jensen, J. N.: A Problem Solving Approach to Aquatic Chemistry. John Wiley &amp; Sons, Inc., New York, 2003.</li> </ul>

Course L0312: Chemistry of Drinking Water Treatment	
Тур	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dr. Klaus Johannsen
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0402: Water Resour	rce Management
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Mathias Ernst
Language	DE
Cycle	WiSe
Content	The lecture provides comprehensive knowledge on interaction of water ressource management and drinking water supply. Content
	overview:         • Current situation of global water resources         • User and Stakeholder conflicts         • Wasserressourcenmanagement in urbane Gebieten         • Rechtliche Aspekte, Organisationsformen Trinkwasserversorgungsunternehmen.         • Ökobilanzierung, Benchmarking in der Wasserversorgung
Literature	<ul> <li>Aktuelle UN World Water Development Reports</li> <li>Branchenbild der deutschen Wasserwirtschaft, VKU (2011)</li> <li>Aktuelle Artikel wissenschaftlicher Zeitschriften</li> <li>Ppt der Vorlesung</li> </ul>

## Module Manual M.Sc. "Civil Engineering"

Course L0403: Water Resour	ourse L0403: Water Resource Management	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Mathias Ernst	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Adaptation to climate change in hy	draulic engineering (L2291)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge	Hydrology, Hydraulic Engineering			
	<ul> <li>Hydromechanic, Hydraulics</li> <li>Fundamentals of Coastal Engineering, Coastal- and F</li> </ul>	load Protection		
	<ul> <li>Hydrological Systems</li> </ul>			
Educational Objectives	After taking part successfully, students have reached the for	llowing learning results		
<b>Professional Competence</b>				
Knowledge	Climate protection and climate adaptation			
	<ul> <li>Insights into climate change and its regional character</li> </ul>	eristics - fundamentals, climate mode	lling / climate	models
	<ul> <li>Impacts of climate change on the components of the</li> </ul>		ing, chinace	modelo
	Fundamentals of analysis of climate data			
	Consequences of the impact of the climate change			
	Measures for climate adaptation			
	Assessment, prioritization and communication of ada	ptation measures		
	<ul> <li>Fundamentals of the analysis of hydrometeorological</li> </ul>	l and hydrological data		
Skills				
SKIIS	Critical thinking: analysis of processes and relations,	assessment of needs for action		
	Creative thinking: development of adaptation strateg			
	<ul> <li>Practical thinking: inclusion of restrictions, application</li> </ul>	tion of calculation approaches, meth	ods, numeric	al models, planr
	methods			
	Consideration of complex tasks			
Personal Competence				
Social Competence				
	Working in heterogenous groups			
	Working with different scientific / non-scientific discip	blines		
	Self reflection			
Autonomy				
	Application oriented use of knowledge and skills			
	Autonomous work on complex tasks			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Preparation of a written report and a presentation of a com	plex task.		
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Election	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering:			
	Civil Engineering: Specialisation Structural Engineering: Electronic Structural Engineering: Electronic Structural Engineering: Electronic Structural Engineering: Specialisation Structural Engineering: Electronic Structural En			
	Civil Engineering: Specialisation Water and Traffic: Elective	Compulsory		
	Water and Environmental Engineering: Specialisation Cities Water and Environmental Engineering: Specialisation Enviro			

Course L2291: Adaptation to	climate change in hydraulic engineering
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	<ul> <li>Climate protection and climate adaptation</li> <li>Findings on climate change and its regional characteristics: fundamentals of climate change, climate modelling / climate models</li> <li>Impacts of climate change on the components of the regional hydrological cycle(climate science view)</li> <li>Fundamentals of the analysis of climate data</li> <li>Concequences of the impacts of climate change (ingenieering science view)</li> <li>Measures for climate change adaptation</li> <li>Assessment, prioritization and communication of measures</li> <li>Fundamentals of analysis of hydrometeorological and hydrological data</li> </ul>
Literature	<ul> <li>Wird bereitgestellt über die HOOU - eLearning Plattform</li> <li>abhängig von den jeweils schwerpunktmäßig behandelten Fragestellungen wird das Schrifttum (aktuelle Paper) in der Veranstaltung bzw. über StudIP zur Verfügung gestellt.</li> </ul>

ect-/problem-based Learning ection arning results er Cycle ent of needs for action daptation measures lculation approaches, meth	Hrs/wk 4	CP 6
ect-/problem-based Learning ection arning results er Cycle ent of needs for action daptation measures	4	
arning results or Cycle ent of needs for action daptation measures	nods, numerical	models, plannir
arning results or Cycle ent of needs for action daptation measures	nods, numerical	models, plannir
arning results or Cycle ent of needs for action daptation measures	nods, numerical	models, plannir
er Cycle ent of needs for action daptation measures	nods, numerical	models, plannir
ent of needs for action daptation measures	nods, numerical	models, plannir
daptation measures	ods, numerical	models, plannir
on and subsequent discussion	on. The work on	the complex ta
compulsory pulsory ory Elective Compulsory		
	ion and subsequent discussion ulsory Compulsory npulsory ory : Elective Compulsory e Compulsory Elective Compulsory e Compulsory	Compulsory npulsory iory : Elective Compulsory e Compulsory

Course L2926: Sustainable N	ature-based Coastal Protection in a Changing Climate (SeaPiaC)
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Peter Fröhle
Language	EN
Cycle	WiSe
Content	<ul> <li>Climate and Climate Change</li> <li>General Impacts of Climate Change on Wind Regime and Water Cycle</li> <li>Consequences of Climate Change for Coastal Processes</li> <li>Coastal Protection in Taiwan and Germany</li> <li>Fundamentals of Climate Adaptation</li> <li>Nature-Based Solutions (NBS) for Coastal Protection</li> </ul>
Literature	<ul> <li>Materials provided on eLearning Platform (HOOU Platform)</li> <li>Depending on the main topics of the course in the respective year, the literature ( recent papers) will be provided in the course-material or via StudIP.</li> </ul>

Module M1844: Mode	rn discretization methods in stru	uctural mechanics		
Courses				
Title		Тур	Hrs/wk	СР
Modern discretization methods in s	tructural mechanics (L3043)	Lecture	2	3
Modern discretization methods in s	tructural mechanics (L3044)	Recitation Section (small)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	<ul><li>Finite Element Methods</li><li>Flächentragwerke</li></ul>			
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, stu mechanics.	dents can express the basic aspects of moder	n discretization r	nethods in structu
Skills	After successful completion of this module, the students will be able to use and further improve modern discretization methods for problems in structural mechanics.			
Personal Competence				
Social Competence	Students can			
	<ul> <li>participate in subject-specific and interdi</li> </ul>	sciplinary discussions.		
	<ul> <li>defend their own work results in front of</li> </ul>			
	<ul> <li>promote the scientific development of co</li> </ul>			
	<ul> <li>Furthermore, they can give and accept p</li> </ul>	•		
Δυτοροφγ	Students are able to gain knowledge of the sub	niect area from given and other sources and a	oply it to new pro	blems Furthermo
, accricing	they are able to structure the solution process			
Workload in Hours	Independent Study Time 124, Study Time in Le	cture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engine	ering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical E	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Engi	neering: Elective Compulsory		
	Civil Engineering: Specialisation Computational	Engineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisat	tion Simulation Technology: Elective Compulso	ry	

Course L3043: Modern discre	etization methods in structural mechanics
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	EN
Cycle	WiSe
Content	<ul> <li>The course covers variational formulations, various locking phenomena and alternative formulations for finite elements and modern discretization schemes in the context of structural mechanics, like isogeometric analysis.</li> <li>variational formulation of finite elements, mixed variational principles</li> <li>geometrical and material locking effects in structural and solid mechanics</li> <li>hybrid-mixed and enhanced assumed strain finite element formulations, reduced integration and stabilization, DSG method, u-p formulations</li> <li>patch test, stability, convergence</li> <li>linear and non-linear analyses</li> <li>introduction to isogeometric analysis</li> <li>isogeometric beam, plate and shell formulations</li> <li>locking effects and their avoidance in modern, smooth discretization schemes, like isogeometric analysis</li> </ul>
Literature	<ul> <li>lecture notes and selected scientific papers</li> <li>O.C. Zienkiewicz, R.L. Taylor, and J.Z. Zhu: Finite Element Method: Its Basis and Fundamentals. Elsevier, 2013.</li> <li>J. Austin Cottrell, Thomas J. R Hughes, Yuri Bazilevs: Isogeometric Analysis: Toward Integration of CAD and FEA. Wiley, 2009.</li> </ul>

Course L3044: Modern discre	urse L3044: Modern discretization methods in structural mechanics	
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Scientific Working in Computationa	Engineering (L2764)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge in scientific writing. String interest in top	cs related to computing in civil engine	ering.	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence				
Personal Competence	course instructors and in collaboration with each other, the students will also learn to understand the complex process of scientific thinking, being able to accurately plan, implement and analyze scientific projects, such as prospective master theses. A project will be conducted throughout the semester, which will contribute to the grade. Since scientific writing is of particular importance in this course, a scientific paper will be developed based, which is a prerequisite for the final examination. The paper will be written based on the project conducted within this course. Project meetings in small groups, presentations, and critical discussions of scientific publications are further key activities. The students will be capable (i) of solving a scientific problem following a scientific methodology, (ii) of documenting their work effectively in the form of a paper, and (iii) of sharing their work in a presentation.			
Autonomy	The students will be able to extend their knowledge and a	oply it to solve scientific problems by w	vorking indepe	ndently in a proje
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	10 pages of work with 15-minute oral presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective	e Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elect	ive Compulsory		
	Civil Engineering: Specialisation Structural Engineering: El	ective Compulsory		
	Civil Engineering: Specialisation Computational Engineerin	g: Elective Compulsory		
	Computer Science: Specialisation II: Intelligence Engineeri	na: Elective Compulsory		

Course L2764: Scientific Wor	rking in Computational Engineering
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	WiSe/SoSe
Content	In the course, a scientific problem of practical relevance will first be defined, taking into account the interests of the students participating in the course. The scientific problem will then systematically be solved within the framework of a comprehensive project. The principles of scientific working will be taught based on the scientific problem defined previously. As an integral part of scientific working, fundamentals of scientific writing will be presented and applied to a scientific paper to be written during the course. Topics related to scientific writing include structuring in scientific writing (structuring the abstract, the introduction, the main part, the summary and conclusions, and the acknowledgments and references) and recommendations on effective scientific writing (principles of composition, use of English in scientific writing, useful tips, creating figures, writing in mathematics, referencing, and formal email correspondence). A final paper and a final presentation will be assembled by the students.
Literature	Smarsly, K. & Dragos, K., 2019. Scientific Writing in Engineering. Tredition, Hamburg, Germany.

-				
Courses				
Fitle	······································	Тур	Hrs/wk	СР
Construction law BGB and VOB - la Construction disputes from constru	ction (excavation) practice (L3182)	Lecture Lecture	2	3 3
Module Responsible				-
Admission Requirements	None			
	Complete modules: Geotechnics I-III			
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	Students will gain knowledge of			
	<ul> <li>the history of civil engineering law,</li> </ul>			
	<ul> <li>basics of foundation and civil engineering</li> </ul>	g law,		
	<ul> <li>legal aspects of technical regulations in c</li> </ul>	ivil engineering (with case studies),		
	<ul> <li>the civil engineering contract,</li> </ul>			
	the liability of the designer and contractor	r in civil engineering,		
	<ul> <li>the subsoil risk and the system risk,</li> <li>the total dabt in (civil) anginagring law</li> </ul>			
	<ul> <li>the total debt in (civil) engineering law,</li> <li>the (construction) conflict, dispute avoidation</li> </ul>	ance models and the construction proc	055	
	<ul> <li>the (construction) connect, dispute avoid</li> <li>the systematics of construction contract</li> </ul>		c35,	
	<ul> <li>the BGB construction contract law,</li> </ul>	,		
	<ul> <li>responsibilities on the construction site,</li> </ul>			
	<ul> <li>remuneration and contract management</li> </ul>	,		
	<ul> <li>liability for defects,</li> </ul>			
	<ul> <li>public procurement law</li> </ul>			
	<ul> <li>Disturbed construction processes: How m</li> </ul>	nuch money am I entitled to?		
	Correct calculation of supplements.			
Skills	Students learn to apply legal aspects in plannir	ng and construction in a legally balanc	ed way. Students learn l	now to use legal a
	construction management aspects in practice (			
	to manage the construction project optimally.			
Personal Competence				
Social Competence	Students can work in groups and support each o	other in finding solutions.		
Autonomy	Students are able to assess their own strengths	and weaknesses and organize their tir	me and learning manage	ment based on thi
Workload in Hours	Independent Study Time 124, Study Time in Lea	cture 56		
Credit points	6			
Course achievement				
Examination	Oral exam			
	30 min			
scale				
•	Civil Engineering: Specialisation Coastal Engine			
Following Curricula	Civil Engineering: Specialisation Geotechnical E			
	Civil Engineering: Specialisation Structural Engin	• • •		
	Civil Engineering: Specialisation Water and Traf	ne. Liective compuisory		

Course L3182: Construction	rse L3182: Construction law BGB and VOB - law in (excavation) practice	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Günther Schalk	
Language	DE	
Cycle	WiSe	
Content		
Literature	Literatur:	
	- Folienskript (in der Vorlesung erhältlich)	
	- Fuchs/Maurer/Schalk: Handbuch Tiefbaurecht	

Course L3181: Construction	rse L3181: Construction disputes from construction (excavation) practice	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Ingo Junker	
Language	DE	
Cycle	WiSe	
Content		
Literature		

Courses					
Title		Тур		Hrs/wk	СР
Coastal- and Flood Protection (L080	8)	Lecture		<b>пі 5/ w к</b> 2	3
Coastal- and Flood Protection (L141	- /		m-based Learning	1	1
Maintenance and Defence of Flood	Protection Structures (L1411)	Lecture	5	2	2
Module Responsible	Prof. Peter Fröhle				
Admission Requirements	None				
<b>Recommended Previous</b>	Coastal Engineering I				
Knowledge					
Educational Objectives	After taking part successfully, students have	e reached the following learning res	ults		
Professional Competence					
Knowledge	The students have the capability to define	and explain in detail the importan	t aspects of erosic	on protection	and flood protecti
	and are able to apply the aspects to prac	tical coastal protection problems.	They are able to	design and o	dimension importa
	coastal protection measures from the functional and from the constructional point of view.				
Skills	//s The students are able to select design approaches for the functional and constructional design of erosion and floor			and flood protect	
measures and apply these approaches to practical design tasks.					
		5			
Personal Competence					
Social Competence	The students are able to deploy their gain	• • • •			-
	coastal and flood protection structures. Add				isciplines.
-	The students will be able to independently e	•,	to new problems.		
	Independent Study Time 110, Study Time in	Lecture 70			
Credit points					
Course achievement	None				
Examination	Written exam				
Examination duration and	The duration of the examination is 130 m	in. The examination includes tasks	s with respect to	the general u	inderstanding of t
scale	lecture contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Coastal Eng	jineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnic	al Engineering: Elective Compulsor	ý		
	Civil Engineering: Specialisation Structural E				
	Environmental Engineering: Specialisation E	nvironment and Climate: Elective C	Compulsory		
	Environmental Engineering: Specialisation V Water and Environmental Engineering: Specialisation			lsory	

Course L0808: Coastal- and F	Course L0808: Coastal- and Flood Protection		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Peter Fröhle		
Language	EN		
Cycle	WiSe		
Content	Protection of sandy coasts		
	<ul> <li>Sediment transport</li> <li>Morphology</li> <li>Technical solution for the protection of sandy coasts <ul> <li>Construction in direction of the coast</li> <li>Constructions perpendicular to the coast</li> <li>Other Concepst</li> </ul> </li> <li>Calculation approaches and numerical models</li> <li>Flood Protection <ul> <li>Classification of constructions / measures</li> <li>Dikes</li> <li>Dunes</li> <li>Foreland - constructions</li> </ul> </li> </ul>		
Literature	Flood-Protection Walls     Drainage of the hinterland Vorlesungsumdruck		
	Coastal Engineering Manual CEM		

Course L1415: Coastal- and I	urse L1415: Coastal- and Flood Protection		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1411: Maintenance	ourse L1411: Maintenance and Defence of Flood Protection Structures	
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Olaf Müller	
Language	EN	
Cycle	WiSe	
Content	<ul> <li>Dike protection</li> <li>Maintennance of flood protection measures</li> </ul>	
Literature	Vorlesungsumdruck	

Courses					
		<b>T</b>	Une fools	<b>CD</b>	
<b>Title</b> Waste and Environmental Chemist	m (10228)	<b>Typ</b> Practical Course	Hrs/wk 2	<b>CP</b> 2	
Biological Waste Treatment (L0318	-	Project-/problem-based Learn		4	
Module Responsible			5		
Admission Requirements					
Recommended Previous					
Knowledge	5				
Educational Objectives		eached the following learning results			
Professional Competence					
	The module aims possess knowledge concernin	og the planning of biological waste treatment	plants Students a	re able to explair	
nnomeage	design and layout of anaerobic and aerobic was				
	plants for biological waste treatment plants and				
Skills	The students are able to discuss the compilatio	on of design and layout of plants. They can cr	iticallv evaluate te	chniques and qua	
	control measurements. The students can rech				
	and plan additional tests. They are capable of r			5	
Personal Competence					
-	Students can participate in subject-specific an	d interdisciplinary discussions, develop coop	erated solutions a	nd defend their	
,	work results in front of others and promote the scientific development in front of colleagues. Furthermore, they can give a				
	accept professional constructive criticism.				
Autonomy	Students can independently tap knowledge fro	om literature, business or test reports and tra	ansform it to the c	ourse projects. T	
	are capable, in consultation with supervisors as	s well as in the interim presentation, to asses	s their learning lev	vel and define fur	
	steps on this basis. Furthermore, they can def	fine targets for new application-or research-	priented duties in	accordance with	
	potential social, economic and cultural impact.				
Workload in Hours	Independent Study Time 110, Study Time in Le	cture 70			
Credit points					
Course achievement		Description			
	Yes None Subject theoretical practical work	and			
F					
Examination					
Examination duration and scale		i groups)			
		aring Elective Compulsory			
Assignment for the Following Curricula		5 1 5			
Tonowing curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Structural Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Vater and Traf	• • •			
	Bioprocess Engineering: Specialisation Water and Hall		sory		
	Chemical and Bioprocess Engineering: Specialis				
	Chemical and Bioprocess Engineering: Specialis	• •			
	Chemical and Bioprocess Engineering: Specialisation Disprocess Engineering: Elective Compulsory				
	Environmental Engineering: Core Qualification:		-		
	International Management and Engineering: Sp	ecialisation II. Renewable Energy: Elective Co	ompulsory		
	International Management and Engineering: Sp Process Engineering: Specialisation Environmer				
		ntal Process Engineering: Elective Compulsor			

Course L0328: Waste and En	vironmental Chemistry
Тур	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	The participants are divided into groups. Each group prepares a transcript on the experiment performed, which is then used as basis for discussing the results and to evaluate the performance of the group and the individual student. In some experiments the test procedure and the results are presented in seminar form, accompanied by discussion and results evaluation. Experiments ar e.g. Screening and particle size determination Fos/Tac AAS Chalorific value
Literature	Scripte

Course L0318: Biological Wa	ourse L0318: Biological Waste Treatment		
Тур	Project-/problem-based Learning		
Hrs/wk	3		
СР	4		
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
Lecturer	Prof. Kerstin Kuchta		
Language	EN		
Cycle	WiSe		
Content	<ol> <li>Introduction</li> <li>biological basics</li> <li>determination process specific material characterization</li> <li>aerobic degradation ( Composting, stabilization)</li> <li>anaerobic degradation (Biogas production, fermentation)</li> <li>Technical layout and process design</li> <li>Flue gas treatment</li> <li>Plant design practical phase</li> </ol>		
Literature			

Courses				
Title		Тур	Hrs/wk	СР
Finite element modeling of structur	es (L3046)	Lecture	2	3
Finite element modeling of structur	es (L3047)	Recitation Section (small)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	<ul><li>Finite Element Methods</li><li>Thin-walled structures</li></ul>			
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, stu	dents can express the basic aspects of modelli	ng of structures v	with finite elements
Skills	After successful completion of this module, the students will be able to model structures with finite elements and to analys structures using appropriate computational methods.			
Personal Competence				
Social Competence	Students can			
	<ul> <li>participate in subject-specific and interd</li> </ul>	isciplinary discussions,		
	<ul> <li>defend their own work results in front of</li> </ul>	others		
	<ul> <li>promote the scientific development of compared on the scientific development of compared on the science of the sc</li></ul>	olleagues		
	<ul> <li>Furthermore, they can give and accept p</li> </ul>	professional constructive criticism		
Autonomy	Students are able to gain knowledge of the sub they are able to structure the solution process			
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	written elaboration of a project work (10-15 pa	ges)		
scale				
Assignment for the	Civil Engineering: Specialisation Computational	Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal Engine	eering: Elective Compulsory		
	Civil Engineering: Specialisation Geotechnical E	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Eng	ineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisa	tion Simulation Technology: Elective Compulso	ry	

ourse L3046: Finite element modeling of structures		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	EN	
Cycle	WiSe	
	<ul> <li>Basic phenomena and aspects of the finite element modelling of structures are discussed. Besides theoretical decription of the phenomena and methods, a strong focus is on the practical use a commercial finite element software within computer-based exercises. The covered topics are: <ul> <li>finite element modeling of trusses/beams/frames, plates subject to in-plane/out-of-plane loading and shells</li> <li>convergence properties of displacements and stresses</li> <li>singularities</li> <li>locking effects</li> <li>critical assessment, interpretation and check of results</li> <li>mixed-dimensional coupling of finite elements</li> <li>geometrically linear and non-linear, and material linear and non-linear analyses</li> <li>stability: bifurcation and snap-through problems</li> <li>dynamic problems, modal analyses</li> </ul> </li> </ul>	
Literature	Vorlesungsmanuskript, Vorlesungsfolien	

Course L3047: Finite elemen	rse L3047: Finite element modeling of structures		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

E.

Module M2033: Subsu	Irface Processes				
	inace Processes				
Courses					
Гitle			Тур	Hrs/wk	СР
Modeling of Subsurface Processes (	L2731)		Recitation Section (small)	3	3
Subsurface Solute Transport (L2728	3)		Lecture	2	2
Subsurface Solute Transport (L2729	9)		Recitation Section (large)	1	1
Module Responsible	Prof. Nima Shokri				
Admission Requirements	None				
<b>Recommended Previous</b>	Basic Mathematics, Hydrology				
Knowledge					
Educational Objectives	After taking part successfully, students ha	ave reached the followin	g learning results		
<b>Professional Competence</b>					
Knowledge	Upon completion of this module, the stu		-		
	porous media and will be able to work wit	th the equations that go	vern the fate and transport of	of solutes in poro	us media. Analytic
	numerical and experimental tools and tec	hniques will be used in t	this module.		
Skills	In addition to the physical insights, the st	udents will be exposed	to analytical experimental a	and numerical to	ols and techniques
Skiis	this module. This provides them with an e				
	future career.	excellence opportunity to	improve their skins on mate	pie nones which	
Personal Competence					
-	Teamwork & problem solving				
	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability and				
Autonomy	willingness to work independently and res		presentation. This will co		students ability a
Workload in Hours	Independent Study Time 96, Study Time in	. ,			
Credit points		Il Ecclure 04			
Course achievement					
	Subject theoretical and practical work				
Examination duration and					
scale					
Assignment for the	Civil Engineering: Specialisation Structura	al Engineering: Elective (	Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechn				
	Civil Engineering: Specialisation Coastal E				
	Civil Engineering: Specialisation Water and				
	Civil Engineering: Specialisation Computat		,		
	Environmental Engineering: Core Qualifica				
	Process Engineering: Specialisation Enviro		eering: Elective Compulsory		
	Process Engineering: Specialisation Proces				
	Water and Environmental Engineering: Sp				
	• • •				
	Water and Environmental Engineering: Sp	pecialisation Environmer	t: Elective Compulsory		

Course L2731: Modeling of Subsurface Processes		
Тур	Recitation Section (small)	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Dr. Milad Aminzadeh	
Language	EN	
Cycle	WiSe	
Content	Basic usage and background of chosen computer software to calculate flow and transport in the saturated and unsaturated zone	
	and to analyze field data like pumping test data	
Literature		

ourse L2728: Subsurface Solute Transport		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Nima Shokri	
Language	EN	
Cycle	WiSe	
Content	Basic physical properties of soil: Definition and quantification; Liquid flow in soils (Darcy's law); Solute transport in soils; Practical analysis to measure dispersion coefficient in soil under different boundary conditions; Advanced topics (e.g. Application of Artificial Intelligence to predict soil salinization)	
Literature	- Environmental Soil Physics, by Daniel Hillel - Soil Physics, Sixth Edition, by William A. Jury and Robert Horton	

ourse L2729: Subsurface Solute Transport	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Hannes Nevermann
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

## **Specialization Geotechnical Engineering**

Module M0699: Geote	chnics III			
Courses				
Title		Turn	Hrs/wk	СР
Numerical Methods in Geotechnics	(10375)	<b>Typ</b> Lecture	BIS/WK 3	3
Advanced Foundation Engineering (	· ·	Lecture	2	2
Advanced Foundation Engineering (		Recitation Section (large)	1	1
Module Responsible	Prof. lürgen Grabe			
Admission Requirements				
	Geotechnics I and II, Mathematics I-III			
Knowledge				
	After taking part successfully, students have reached the for	ollowing learning results		
Professional Competence				
	After successfully completing the module, students will be a	able to		
	· · · · · · · · · · · · · · · · · · ·			
	<ul> <li>describe individual procedures for the geotechnical r</li> </ul>	nonitoring of civil engineering me	asures,	
	<ul> <li>reproduce exploration and investigation methods of</li> </ul>			
	<ul> <li>select suitable types of field and laboratory tests for</li> </ul>			
	<ul> <li>state the differences between various stress and def</li> </ul>	ormation states and the physical	significance of inv	variants of the stress
	and distortion tensor,			
	<ul> <li>outline the standard and special soil mechanics tests</li> </ul>		in benavior of soi	11,
	describe continuum models and the resulting bounda     as well as define boundary value problems from the		in such a way that	t those can be called
	<ul> <li>as well as define boundary value problems from the unambiguously.</li> </ul>	neid of geotechnical engineering	in such a way tha	it they can be solved
Skills	Students will be able to			
	• dimension vertical drains for soil improvement of sof	t soils,		
	calculate depth compaction using various appropriat	e methods,		
	apply principles of horizontal bearing capacity of pile	25,		
	<ul> <li>verify the internal and external stability of fluid-supp</li> </ul>	orted diaphragm walls,		
	<ul> <li>evaluate the boundary conditions for the design</li> </ul>	of a deep excavation and desig	n the individual	components of the
	excavation,			
	<ul> <li>perform, evaluate and interpret tests for the descript</li> </ul>	tion and classification of soils acco	rding to applicabl	e standards,
	<ul> <li>computationally implement numerical algorithms to</li> </ul>	solve boundary value problems,		
	<ul> <li>select and apply the types of analyses depending on</li> </ul>	the degree of saturation, the imp	act, and the mate	erial behavior
	determine appropriate model parameters for different	nt possibilities and limitations of n	naterial models fo	or the grain structure
	of soils.			
Personal Competence				
	Students can work in groups and support each other in find	ing solutions.		
social competence				
Autonomy	Students are able to assess their own strengths and weakn and think in terms of processes.	esses and, based on this, organize	their time and le	arning management
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination				
Examination duration and				
scale				
	Civil Engineering: Specialisation Structural Engineering: Cor	mpulsory		
	Civil Engineering: Specialisation Coastal Engineering: Comp			
	Civil Engineering: Specialisation Water and Traffic: Elective	•		
	Civil Engineering: Specialisation Computational Engineering			
	International Management and Engineering: Specialisation		pulsory	
	- • • • •			

Course L0375: Numerical Methods in Geotechnics		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Dr. Hans Mathäus Stanford	
Language	DE	
Cycle	WiSe	
Content	Topics:	
	<ul> <li>Introduction to numerical soil mechanics</li> <li>Introduction to numerical mathematics</li> <li>Finite Element Method (analysis procedures, algorithms)</li> <li>Finite Element Method (application in geotechnical engineering)</li> </ul>	
Literature	<ul> <li>Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden. Springer</li> <li>Wriggers P. (2008): Nonlinear Finite Element Methods. Springer</li> <li>Deutsche Gesellschaft für Geotechnik e.V. (Hrsg., 2014): Empfehlungen des Arbeitskreises "Numerik in der Geotechnik". Ernst &amp; Sohn</li> </ul>	

Course L0497: Advanced Foundation Engineering		
Тур	ecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Jürgen Grabe	
Language	DE	
Cycle	WiSe	
Content	<ul> <li>Vertical drains</li> <li>Piles</li> <li>Ground improvement (Deep Compaction, Soil mixing)</li> <li>Vibration driving</li> <li>Jet grouting</li> <li>Slurry wall</li> <li>Deep excavation</li> </ul>	
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>EAB (1988): Empfehlungen des Arbeitskreises Baugruben</li> <li>Grundbau-Taschenbuch, Teil 1-3, (1997), Ernst &amp; Sohn Verlag</li> </ul>	

Course L0498: Advanced Foundation Engineering	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses						
Title				Тур	Hrs/wk	СР
Applied Tunnel Constructions (L24)	)7)			Lecture	2	3
Introduction to tunnel construction				Lecture	1	2
ntroduction to tunnel construction	(L1811)			Recitation Section (large)	1	1
Module Responsible	Prof. Jürgen Grabe					
Admission Requirements	None					
<b>Recommended Previous</b>	Modules from Bachel	or studies Civil a	and environmental engin	eering:		
Knowledge						
	<ul> <li>Geotechnics I-</li> </ul>	11				
Educational Objectives	After taking part suc	cessfully, studen	ts have reached the foll	wing learning results		
Professional Competence						
Knowledge	Knowledge of different tunnel construction types as well as special methods and techniques of subsoil construction.					
Skills	Basic knowledge of tunnel design as well as practical skills in structural tunnel analysis.					
Personal Competence						
Social Competence	Capacity for teamwork concerning project management and design of tunnels.					
Autonomy	Promotion of indeper	ndent and creativ	ve work flow in the fram	ework of a design exercise.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56					
Credit points	6					
Course achievement Compulsory Bonus Form Description						
	No 5 %	Excercises				
Examination	Written exam					
Examination duration and	120 minutes					
scale						
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory					
Following Curricula	Civil Engineering: Sp	ecialisation Geot	echnical Engineering: C	ompulsory		
	Civil Engineering: Sp	ecialisation Coas	stal Engineering: Compu	sory		
	Civil Engineering: Sp	ecialisation Wate	er and Traffic: Elective C	ompulsory		
	Civil Engineering: Sp	ecialisation Com	putational Engineering:	Elective Compulsory		
	International Manage	mont and Engin	ooring, Crossiplication II	Civil Engineering: Elective Comp		

Course L2407: Applied Tunnel Constructions			
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Jürgen Grabe, Tim Babendererde		
Language	DE		
Cycle	WiSe		
Content			
Literature			

Course L0707: Introduction t	o tunnel construction		
Тур	Lecture		
Hrs/wk	1		
CP			
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Dr. Julian Bubel		
Language	DE		
Cycle	WiSe		
Content	<ul> <li>Definitions</li> <li>Historical development in tunneling</li> <li>Geology for tunneling</li> <li>Hard rock tunneling (construction composite and machines)</li> <li>Tunnelung in temporarly stable soil with conventional construction methods</li> <li>Tunneling in soft soils (form of supports, shield types, compressed air application)</li> <li>Pipe jacking</li> <li>Tunnel Lining, tunnel supporting structures</li> <li>Calculation approaches for supporting structures in shield-driven tunnels</li> <li>Surveying for tunneling</li> <li>Safety requirements</li> <li>Construction Contract</li> <li>Literature and sources</li> </ul>		
Literature	<ul> <li>Vorlesung/Übung s. www.tu-harburg.de/gbt</li> </ul>		

Course L1811: Introduction to tunnel construction			
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Dr. Julian Bubel		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M1748: Const	
Courses	
Fitle	Typ Hrs/wk CP
Construction Robotics (L2867) Module Responsible	Project-/problem-based Learning 6 6 Prof. Kay Smarsly
Admission Requirements	
Recommended Previous	
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Basics of robotics
	Applications in civil engineering
	Kinematics
Skills	Use of specific hardware
	Development of software routines
	Python programming language
	Image processing
	Basics of localization (LIDAR, SLAM)
Personal Competence	
Social Competence	Teamwork
	Communication skills
Autonomy	Independent work
	Independent decisions
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	
scale	
-	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Following Curricula	
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Computational Engineering: Elective Compulsory
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory
	Mechatronics: Core Qualification: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory

Тур	Project-/problem-based Learning		
Hrs/wk	6		
СР			
Workload in Hours	ndependent Study Time 96, Study Time in Lecture 84		
Lecturer	Prof. Kay Smarsly, Jan Stührenberg		
Language	EN		
Cycle	WiSe		
Content	<ol> <li>Introduction: Robotics in civil engineering</li> <li>Presentation of potential topics</li> <li>Programming of algorithms in Python</li> <li>Application of software systems: LINUX distribution, ROS, CloudCompare,</li> <li>Application of hardware systems: Petoi Bittle Dog, Raspberry Pi, Arduino, sensing</li> <li>Topics considered for robotics using the Petoi Bittle Dog:         <ol> <li>Movement</li> <li>Use of sensors (camera, infrared,)</li> <li>Data structures/data acquisition</li> <li>Programming</li> </ol> </li> <li>Topics technically relevant to building inspection:         <ol> <li>Geodetic evaluations</li> <li>Image processing</li> <li>Localization</li> </ol> </li> </ol>		
Literature	Bock/Linner: Construction Robotics		
	Verl et al.: Soft Robotics		
	Pasquale: New Laws of robotics		

Courses				
Title		Тур	Hrs/wk	СР
Digital Twinning in Civil Engineerin	g (L3136)	Lecture	2	2
Digital Twinning in Civil Engineerin	g (L3137)	Seminar	2	4
Module Responsible	Alexander Chmelnizkij			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Tin	ne in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	20 min presentation and 5 pages hando	out		
scale				
Assignment for the	Civil Engineering: Specialisation Compu	tational Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotec	hnical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structu	ral Engineering: Elective Compulsory		

Course L3136: Digital Twinning in Civil Engineering		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly	
Language	DE	
Cycle	SoSe	
Content		
Literature		

Course L3137: Digital Twinn	Course L3137: Digital Twinning in Civil Engineering			
Тур	Seminar			
Hrs/wk	2			
СР	4			
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28			
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly			
Language	DE			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

## Module M0593: Building Materials and Building Preservation

Courses						
Title			Тур		Hrs/wk	СР
Repair of Structures (L0255)			Lectu	ıre	1	1
Mineral Building Materials (L0253)			Lectu	ıre	2	2
Technology of mineral Building Materials (L0256) Project-/problem-based Learning 1				1	2	
Transport Processes in Building Ma	erials and Damage Processes (L02	54)	Lectu	ıre	1	1
Module Responsible	Prof. Frank Schmidt-Döhl					
Admission Requirements	None					
<b>Recommended Previous</b>	Basic knowledge about buildir	ig materials, build	ing physics and bu	ilding chemistry, for exam	nple by the m	nodules Principles
Knowledge	Building Materials and Building	Physics and Buildin	ng Materials and Bui	lding Chemistry.		
Educational Objectives	After taking part successfully, s	tudents have reac	hed the following lea	irning results		
Professional Competence						
Knowledge	The students are able to descri	be the components	s of mineral building	materials and their function	on in detail and	d to use them for t
	manufacture of special mineral	building materials	. They are able to sh	ow the characteristics of m	nineral buildin	g materials. They a
	able to describe the manufactu	re, properties and	fields of application	of special mortars and spe	cial concretes	and the correlation
	of their material parameters. Th	ney are able to sho	w the principles of a	nchor technology and desi	gn.	
Chille	The shudents are able to reaf-		- f		These and a bi	
SKIIIS	The students are able to perfor		. ,	-		• •
	mineral mortar and to manufac					
	able to recognize damages, to and strengthening measures.	assess possible ca	auses, to use the fu	ndamentals of construction	n preservation	and to select rep
Personal Competence						
Social Competence	The students are able to develo					
	other students. In a critical discussion they defend and adjust their results. The students are able to manufacture their spec					
	building material on the basis o	f this feedback.				
Autonomy	my The students are able to responsibly use the resources of materials and lab equipment for their project and to investigate and					
	get missing components.					
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70					
Credit points	6					
Course achievement	Compulsory Bonus Form		Description			
	Yes 20 % Subject	theoretical an	ıd			
	practica	l work				
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	Civil Engineering: Specialisatior	n Geotechnical Eng	ineering: Compulsor	У		
Following Curricula	Civil Engineering: Specialisatior	n Coastal Engineeri	ing: Elective Compul	sory		
	Civil Engineering: Specialisatior	n Structural Engine	ering: Elective Comp	oulsory		
	Civil Engineering: Specialisatior					

Course L0255: Repair of Stru	Course L0255: Repair of Structures				
Тур	Lecture				
Hrs/wk	1				
СР	1				
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14				
Lecturer	Prof. Frank Schmidt-Döhl				
Language	DE				
Cycle	SoSe				
Content	Maintenance of structures, repair and strengthening, subsequent waterproofing of structures				
Literature	BetonMarketing Deutschland (Hrsg.): Stahlbetonoberflächen - schützen, erhalten, instandsetzen				

Course L0253: Mineral Buildi	ing Materials
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	SoSe
Content	Components of mineral building materials and their function, binding materials, concrete and mortar, special mortars, special concretes
Literature	Taylor, H.F.W.: Cement Chemistry
	Springenschmid, R.: Betontechnologie für die Praxis

Course L0256: Technology of	Course L0256: Technology of mineral Building Materials	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Design and production of a special mineral building material	
Literature	Taylor, H.F.W.: Cement Chemistry	
	Springenschmid, R.: Betontechnologie für die Praxis	

Course L0254: Transport Pro	Course L0254: Transport Processes in Building Materials and Damage Processes	
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Transport Processes in Building Materials and Damage Processes	
Literature	Blaich, J.: Bauschäden, Analyse und Vermeidung	

Courses				
Title		Тур	Hrs/wk	СР
Design of Prestressed Structures a	nd Concreet Bridges (L0603)	Lecture	3	4
Design of Prestressed Structures a	nd Concreet Bridges (L0604)	Recitation Section (large)	2	2
Module Responsible	NN			
Admission Requirements	None			
<b>Recommended Previous</b>	Detailed knowledge on the design of concr	rete structures.		
Knowledge	Madulaa, Dainfanaad Cananata Churchuraa I	U. Chrysteinel Analysia I. U. Mashanina I. U. Conser	-t- Church uno	
	Modules: Reinforced Concrete Structures I	+II, Structural Analysis I+II, Mechanics I+II, Concre	ete Structures	
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	The students know the main bridge types	s, their applications and the various loads. They	can explain the b	asic design meth
	They can explain the design of a prestress	ed bridge.		
CI-ill-	The shudents are able to design asinfarred			
SKIIIS	The students are able to design reinforced	for prestressed concrete bridges.		
Personal Competence				
Social Competence	The students can design in teamwork a rea	al concrete bridge.		
4	The students are able to desire a super-			
Αυτοποτηγ	The students are able to design a prestres	sed concrete bridge and discuss the problems and	i results with othe	r students.
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 minutes			
scale				
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechni	ical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Er	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory		
	International Management and Engineering			

Course L0603: Design of Pre	stressed Structures and Concreet Bridges
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	NN
Language	DE
Cycle	SoSe
Content	prestressed structures
	<ul> <li>basis of prestressed structures, field of application</li> <li>differences between reinforced and prestressed concrete structures</li> <li>history of prestressing</li> <li>construction materials: concrete, tendons, ducts, anchorage systems</li> <li>construction: prestressing methods</li> <li>prestressing forces and member forces (friction, elongation)</li> <li>tendon layout</li> <li>time dependant prestressing losses</li> <li>design of prestressed structures</li> <li>design of anchorage region</li> <li>non-bonded prestressing</li> <li>prestressed flat slabs</li> </ul>
	Concrete bridges <ul> <li>history of bridges</li> <li>design of bridges</li> <li>loads on bridges</li> <li>loads on bridges</li> <li>member forces for slab, T-beam, hollow box, frame and arch bridges</li> <li>precast bridges - precast segmental bridges</li> <li>bearings</li> <li>abutments, columns</li> <li>construction methods</li> <li>damages - checking of bridges</li> </ul>
Literature	<ul> <li>Vorlesungsumdruckim STUDiP</li> <li>Rombach, G. (2003): Spannbetonbau. Ernst &amp; Sohn, Berlin</li> <li>Wicke, M. (2002): Anwendung des Spannbetons. Betonkalender 2002, Teil II, S. 113-180, Verlag Ernst &amp; Sohn, Berlin</li> <li>Leonhardt, F. (1980): Vorlesungen über Massivbau. Teil 5: Spannbeton. Berlin</li> <li>Mehlhorn, G. (2007): Handbuch Brücken, Springer Verlag</li> <li>Schäfer, H.; Kaufeld, K. (1997): Massivbrücken. Betonkalender Teil II, S. 443ff, Ernst &amp; Sohn, Berlin</li> <li>Menn, Ch. (1986): Stahlbetonbrücken. Springer Verlag, Wien</li> </ul>

Course L0604: Design of Pre	ourse L0604: Design of Prestressed Structures and Concreet Bridges	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	NN	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

	lechanics and -Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Soil Mechanics - Selected Topics (L	0374)	Lecture	2	2
Soil Dynamics (L0452)		Lecture	2	2
Experimental Researches in Geote	hnics (L0706)	Practical Course	2	2
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
<b>Recommended Previous</b>	Modules: Mathematics I-III, Mechanics I-II, Ge	otechnics I		
Knowledge	Courses: Soil laboratory course, (Applied stru	ctural dynamics)		
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	Students will be able to,			
	<ul> <li>to measure vibrations and to interpret</li> <li>justify when elastodynamic methods a</li> <li>to reproduce the collapse theorems of</li> <li>describe the viscous behavior of coh shear strengths</li> </ul>	nd under dynamic excitation and define th the data obtained with regard to their effer re sufficient and when plastodynamic effer plasticity theory, esive soils and computationally account artial saturation on the seepage flow and t	ect on people and struc cts must be taken into for creep deformation	tures, account,
Skills	After the successful completion of the modul		-	
	<ul> <li>to derive and apply the basic equation</li> </ul>	of a simple mass oscillator		
		the soil under dynamic excitation and to	detect the relevant par	ameters
		eld tests to determine soil dynamic charac		
	<ul> <li>to design machine foundations to dyna</li> </ul>			
	<ul> <li>to measure shocks to perform vibratio</li> </ul>			
	<ul> <li>to evaluate shocks in terms of their eff</li> </ul>			
	<ul> <li>to evaluate possibilities of isolation,</li> </ul>			
	• to understand mechanisms that cause	earthquakes and evaluate earthquakes in	terms of their magnitu	ide and intensity,
	• to know methods to determine axial p	le capacity, integrity, and the dynamic be	dding modulus,	
	<ul> <li>to know the mechanisms that lead to mathematically,</li> </ul>	a deformation accumulation due to cyclic	loading and to estimate	e these deformatio
	<ul> <li>to distinguish the area of application of</li> </ul>	f the method of elastodynamics and plasto	odynamics,	
	<ul> <li>to detect the undrained shear strength</li> </ul>	as a function of a number of state variable	es,	
	calculations,	nesive soils and to consider the effects of	creep and rate-depend	ent shear strength
	<ul> <li>to consider the impact of the partly sa</li> </ul>	turated of a seepage and shear strength.		
Personal Competence				
Social Competence	Students will be able to work in teams to ac	hieve results on measurement and exper	imental principles and	present their resu
	together at the end of the semester.			
Autonomy	Students are able to assess their own strengths and weaknesses and organize their time and learning management based on this.			
Workload in Hours	Independent Study Time 96, Study Time in Le	ecture 84		
Credit points	6	2		
Course achievement	Compulsory         Bonus         Form           Yes         None         Subject         theoretical	Description and		
Eveninet'	practical work			
Examination	Written exam			
Examination duration and scale	135 min			
Assignment for the	Civil Engineering: Specialisation Structural Er	gineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnica			
<b>3</b> • • • • •	Civil Engineering: Specialisation Coastal Engi			
	Civil Engineering: Specialisation Computation			

Course L0374: Soil Mechanics	s - Selected Topics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Hans Mathäus Stanford
Language	DE
Cycle	SoSe
Content	selected topis:
Literature	<ul> <li>Stress-strain behaviour (experiments, observations, models)</li> <li>Hydraulic behaviour (experiments, observations, models)</li> <li>Physical modelling (similarity theory, 1g model tests, ng model tests)</li> <li>Limit and safety analysis (collapse theorems of plasticity theory, upper and lower bound analysis, limit equilibrium analysis, numerical analysis)</li> <li>Heat transport (heat conduction, convective heat transport, freezing/thawing)</li> <li>Kolymbas D. (2019): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. Springer Verlag, 5. Auflage</li> <li>Muir Wood D. (2004). Geotechnical modelling. CRC Press</li> <li>Nova, R. (2010). Soil mechanics. Wiley</li> <li>Verruijit, A. (2012). Soil mechanics. u r l: https://geo.verruijt.net</li> <li>Verruijit A. (2018). An introduction to soil mechanics. Vol. 30, Springer Series Theory and Applications of Transport in Porous Media</li> </ul>

Course L0452: Soil Dynamics		
Тур	Lecture	
Hrs/wk	2	
СР		
Workload in Hours	dependent Study Time 32, Study Time in Lecture 28	
Lecturer	Anne Hagemann	
Language		
Cycle	SoSe	
Content	mass-spring-damper systems,	
	• wave propagation in soils,	
	dynamic soil parameters,	
	• Determination of dynamic soil parameters,	
	• machine foundations,	
	• in-situ measurement of ground motion, ground motion prediction, evaluation of ground motion,	
	• ground motion shielding,	
	introduction into earthquake engineering,	
	• dynamic pile tests,	
	• cyclic accumulation,	
	• plastodynamics	
Literature	<ul> <li>Das B.M.: Fundamentals of Soil Dynamics, Elsevier</li> <li>Empfehlungen des Arbeitskreises Baugrunddynamik. Hrsg. Deutsche Gesellschaft für Geotechnik (DGGT)</li> <li>Haupt W.: Bodendynamik. Vieweg und Teubner</li> <li>Meskouris K. und Hinzen KG.: Bauwerke und Erdbeben. Vieweg Verlag</li> <li>Studer J.A., Koller M.G. und Laue J.: Bodendynamik, Springer Verlag</li> </ul>	

Course L0706: Experimental	Researches in Geotechnics
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Hans Mathäus Stanford, Göta Bürkner
Language	DE
Cycle	SoSe
Content	The students are supposed to:
	<ul> <li>become acquainted with geotechnical model tests, field tests and laboratory tests as well as corresponding measurement techniques. These compromise amongst others inclinometer measurements and geophone measurements as well as high-grade laboratory tests on the stress-strain relationship of soil specimens, e. g. triaxial tests, simple shear tests and resonant column tests.</li> <li>gain insight into current soil mechanical research.</li> <li>plan, coordinate, perform and evaluate soil mechanical tests in a team.</li> <li>discuss, reflect, review and present the obtained results in a group.</li> </ul> An important learning target is the introduction to scientific work for students who plan a scientific career, and for those who will work in practice with the responsibility to order corresponding tests and evaluate the results. The practical laboratory work is based on annualy changing problems, which are however related to the experience and results of the preceding year's course group.
Literature	- Grabe, J. (2004): Bodenmechanik und Grundbau, Band 3 der Veröffentlichungsreihe des Instituts für Geotechnik und Baubetrieb, Technische Universität Hamburg-Harburg.
	- Kolymbas, D. (2007): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. 2., korrigierte und ergänzte Auflage, Springer Verlag.
	<ul> <li>Normen zu geotechnischen Versuchsgeräten und Versuchsverfahren:</li> <li>DIN 18135:2012-04: Baugrund, Untersuchung von Bodenproben -</li> <li>Eindimensionaler Kompressionsversuch, Deutsches Institut für</li> <li>Normung, e. V.</li> </ul>
	- DIN 18137-2:2011-04: Baugrund, Untersuchung von Bodenproben - Bestimmung der Scherfestigkeit - Teil 2: Triaxialversuch, Deutsches Institut für Normung e. V.

Module M0827: Mode	ling in Water Management			
	<b>,</b>			
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modfle		Lecture	1	1
Groundwater Modeling using Modflo Modeling of Water Supply Network		Recitation Section (small) Project-/problem-based Learning	2 2	2 3
Module Responsible		rioject-problem-based Learning	2	5
Admission Requirements				
Recommended Previous				
Knowledge				
Ĵ	<ul> <li>groundwater hydraulics and transport or</li> </ul>	fsubstances		
	Pipe Systems			
	Knowledge on urban water infrastruct	ures, in particular drinking water systemsand ι	ırban drainag	e systems includin
	special structures		-	
	<ul> <li>Hydraulics of drinking water supply syst</li> </ul>	ems and sewer systems		
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence		-		
Knowledge	The students are able to describe the modellin	g of groundwater flow and transport as well as urb	an water infra	astructures. They ca
	carry out systems analyses and can detect tee	hnical and conceptual weak points within the sys	tems in case s	studies. Besides the
	are able to analyse interdependencies of hydra	aulic and toxic phenomena in soil and water.		
Skills The students are able to construct and apply scientific groundwater models indipendently. They can wor		y can work o	n different scenarios	
		for existing problems by application of selected so	oftware produ	cts. The students are
	able to use different software solutions (e.g. El	PANET, EPA-SWMM).		
Personal Competence				
Social Competence	Wird nicht vermittelt.			
A £	Wird night vormittalt			
Αυτοπόπγ	Wird nicht vermittelt.			
	Independent Study Time 110, Study Time in Le	ecture 70		
Credit points				
Course achievement				
Examination				
Examination duration and scale	30 min			
	Civil Engineering, Specialization Structured Fra	incoring Elective Compulsory		
•	Civil Engineering: Specialisation Structural Eng Civil Engineering: Specialisation Geotechnical	•		
i onowing curricula	Civil Engineering: Specialisation Coastal Engine			
	Civil Engineering: Specialisation Water and Tra	•		
	Civil Engineering: Specialisation Computationa			
	Water and Environmental Engineering: Special			
	• • •			
	Water and Environmental Engineering: Special	isation Cities: Elective Compulsory		

Course L0543: Groundwater	Modeling using Modflow
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Sonja Götz
Language	DE/EN
Cycle	SoSe
Content	Introduction and application of the groundwater model MODFLOW (PMWIN); theoretical backround of the modell, students do work
	with the model PMWIN for practical case studies.
Literature	MODFLOW-Handbuch
	Chiang, Wen Hsien: PMWIN

Course L0544: Groundwater	urse L0544: Groundwater Modeling using Modflow	
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Sonja Götz	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0875: Modeling of V	Course L0875: Modeling of Water Supply Network		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Klaus Johannsen		
Language	DE		
Cycle	SoSe		
Content			
Literature	Mutschmann/Stimmelmayr: Taschenbuch der Wasserversorgung, 16. Auflage. Springer Vieweg - Verlag. Wiesbaden 2014.		

Courses				
Title		Тур	Hrs/wk	СР
Noise Protection (L1109)		Lecture	2	2
Urban Infrastructures (L0874)		Project-/problem-based Learning	2	4
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge	Knowledge on Urban planning			
	Knowledge on measures for climate protection			
	General knowledge of scientific writing/working			
Educational Objectives	After taking part successfully, students have reached the following	g learning results		
<b>Professional Competence</b>				
Knowledge	Students can describe urban development corridors as well as cu	rrent and future urban environr	mental probler	ns. They are able
	explain the causes of environmental problems (like noise).			
	Students can specify applications for various technical innovation	is and explain why these contril	bute to the im	provement of urb
	life. They can, for example, derive and discuss measures for effective noise abatement.			
Skills Students are able to develop specific solutions for correcting existing or future environment-related pr		problems of urb		
Skins	development. They can define a range of conceptual and technical solutions for environmental problems for different de			
	paths. To solve specific urban environmental problems they can			
	context.		5	
Personal Competence				
Social Competence	The students can work together in international groups.			
Autonomy	Students are able to organize their work flow to prepare themse	luce for presentations and cont	ributions to th	o discussions. Th
Autonomy				le discussions. In
	can acquire appropriate knowledge by making enquiries independ	ienuy.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Written Report plus oral Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective C	Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Electiv	ve Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective Cor	npulsory		
	Civil Engineering: Specialisation Water and Traffic: Elective Comp	ulsory		
	Environmental Engineering: Core Qualification: Elective Compulso	ry		
	Joint European Master in Environmental Studies - Cities and Susta	inability: Core Qualification: Cor	mpulsory	
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure	and Mobility: Elective Compuls	ory	
	Water and Environmental Engineering: Specialisation Environmen	t: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Environment Water and Environmental Engineering: Specialisation Cities: Comp			

Course L1109: Noise Protect	ion
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Jäschke
Language	EN
Cycle	SoSe
Content	
Literature	1) Müller & Möser (2013): Handbook of Engineering Acoustics (also available in German)
	2) WHO (1999): Guidelines for Community Noise
	3) Environmental Noise Directive 2002/49/EG
	4) ISO 9613-2 (1996): Acoustics, Attenuation of sound during propagation outdoors, Part 2: General method of calculation

Course L0874: Urban Infrast	ructures
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Dr. Dorothea Rechtenbach
Language	EN
Cycle	SoSe
Content	Problem Based Learning Main topics are: • Central vs. Decentral Wastewater Treatment. • Compaction of Cities.
	<ul> <li>Car Free Cities.</li> <li>Multifunctional Places in Cities.</li> <li>The Sustainability of Freight Transport in Cities.</li> </ul>
Literature	Depends on chosen topic.

Courses				
Title		Тур	Hrs/wk	СР
Harbour Engineering (L0809)		Lecture	2	2
Harbour Engineering (L1414)		Project-/problem-based Learning	1	2
Port Planning and Port Construction	n (L0378)	Lecture	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of coastal engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the for	bllowing learning results		
Professional Competence				
Knowledge	The students are able to define in details and to choose design approaches for the functional design of a port and apply then			
	design tasks. They can design the fundamental elements o	f a port.		
CL 111	The students are able to select and apply appropriate approaches for the functional design of ports.			
SKIIIS	The students are able to select and apply appropriate appr	baches for the functional design of po	rts.	
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge i	n applied problems such as the funct	tional design	of ports. Additiona
	they will be able to work in team with engineers of other di	sciplines.		
Autonomy	The students will be able to independently extend their know	wledge and apply it to new problems		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 150 min. The examin	ation includes tasks with respect to	the general u	understanding of
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Ele	ctive Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering:	Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Comp	pulsory		
	Civil Engineering: Specialisation Water and Traffic: Elective	Compulsory		
	International Management and Engineering: Specialisation	II. Civil Engineering: Elective Computs	orv	

Course L0809: Harbour Engineering	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	SoSe
Content	<ul> <li>Fundamentals of harbor engineering <ul> <li>Maritime transportation and waterways engineering</li> <li>Ships</li> </ul> </li> <li>Elements of harbors <ul> <li>Harbor approaches and water-side harbor areas</li> <li>Terminal design and handling of cargo</li> <li>Quay-walls and piers</li> <li>Equipment of harbors</li> <li>Sluices and other special constructions</li> </ul> </li> <li>Connection to inland transportation / inland waterway transportation</li> <li>Protection of harbors <ul> <li>Breakwaters and Jetties</li> <li>Wave protection of harbors</li> </ul> </li> <li>Fishery and other small harbors</li> </ul>
Literature	Brinkmann, B.: Seehäfen, Springer 2005

Course L1414: Harbour Engi	urse L1414: Harbour Engineering	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Peter Fröhle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Hrs/wk 2 CP 2	
Vendelaged in Llaure	2
Vorkioad in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Frank Feindt
Language	DE
Cycle	SoSe
Content	<ul> <li>Planning and implementation of major projects</li> <li>Market analysis and traffic relations</li> <li>Planning process and plan</li> <li>Port planning in urban neighborhood</li> <li>Development of the logistics center "Port of Hamburg" in the metropolis</li> <li>Quays and waterfront structure</li> <li>Special planning Law Harbor - securing of a flexible use of the port</li> <li>Dimensioning of quays</li> <li>Flood protection structures</li> <li>Port of Hamburg - Infrastructure and development</li> <li>Preparation of areas</li> <li>Scour formation in front of shore structures</li> </ul>

Courses				
Title		Түр	Hrs/wk	СР
Hydraulic Models (L0813)		Project-/problem-based Learning	1	1
Modelling of Waves (L0812)		Project-/problem-based Learning	1	1
Modelling of Flow in Rivers and Est	uaries (L0810)	Lecture	3	4
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>	Coastal Hydraulic Engineering I			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following part successfully and the students have reached the following part successfully and the students have reached the students have been successfully as the students have reached the students have been successfully as the stude	owing learning results		
<b>Professional Competence</b>				
Knowledge	<i>nowledge</i> Students are able to define in detail the basic processes that are related to the modelling of flows in hydraulic effective structures are able to define in detail the basic processes that are related to the modelling of flows in hydraulic effective structures are able to define in detail the basic processes that are related to the modelling of flows in hydraulic effective structures are able to define in detail the basic processes that are related to the modelling of flows in hydraulic effective structures are able to define in detail the basic processes that are related to the modelling of flows in hydraulic effective structures are able to define an effective structure structure structure structures are able to define an effective structure structure structure structure structures are able to define an effective structure structure structure structure structures are able to define an effective structure structure structure structure structures are able to define an effective structure structure structure structure structure structures are able at the structure struc		ydraulic engineerir	
	Besides, they can describe the basic aspects of numerical modelling and actual numerical models for the simulation of flows an			
	waves.			
Skills	Students are able to apply hydrodynamic-numerical models t	o practical hydraulic engineering ta	ckc	
JKIIIS	Students are able to apply hydrodynamic-numerical models to practical hydraulic engineering tasks.			
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in si	mple applied problems. Additionaly	, they will be	able to work in tea
	with others.			
Autonomy	The students will be able to independently extend their know	ledge and apply it to new problems		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 3 hours. The examination	on includes tasks with respect to	the general ι	understanding of t
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elect	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: El	ective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective	Compulsory		
	Civil Engineering: Specialisation Computational Engineering:			

Course L0813: Hydraulic Mod	dels
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>Fundamentals of hydraulic models</li> <li>Model laws</li> <li>Pi theorem of Buckingham</li> <li>Practical examples of hydraulic models</li> </ul>
Literature	Strobl, Zunic: Wasserbau, Kap. 11 Hydraulische Modelle, Springer

Course L0812: Modelling of	Waves
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>Waves, interactions with shallow water and constructions</li> <li>Wave theories</li> <li>Sea state and surges</li> <li>Development of waves</li> <li>Wave spectra</li> <li>Modelling of Waves / phase averaged and phase resolved models</li> <li>Application of a phase averaged model for wave prediction (SWAN)</li> <li>Application of phase resolved wave models (Mike)</li> </ul>
Literature	Vorlesungsumdruck

Course L0810: Modelling of I	
	Lecture
Hrs/wk	
СР	4
	Independent Study Time 78, Study Time in Lecture 42
	Prof. Edgar Nehlsen, Prof. Peter Fröhle
Language	
Cycle	SoSe Introduction to numerical flow modelling
	<ul> <li>Processes affecting tht flow</li> <li>Examples and applications of numerical models</li> <li>Procedure of numerical modelling</li> <li>Model concept</li> <li>Basic equations of hydrodynamics</li> <li>Saint-Venant equations</li> <li>Euler Equations</li> <li>Navier-Stokes equations</li> <li>Reynolds-averaged Navier-Stokes equations</li> <li>Shallow water equations</li> </ul>
	Solving schemes  • Numerical discretization  • Solution algorithms • Convergence
Literature	Vorlesungsskript
	Bund der Ingenieure für Wasserwirtschaft, Abfallwirtschaft und Kulturbau (1997): Hydraulische Berechnung von naturnaher Fließgewässern. Düsseldorf: BWK (BWK-Merkblatt). Chow, Ven-te (1959): Open-channel Hydraulics. New York usw.: McGraw-Hill (McGraw-Hill Civil Engineering Series). Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019a): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 1: Geodaten in der Fließgewässermodellierung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-1).
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019b): Merkblatt DWA-M 543-2 Geodaten in de Fließgewässermodellierung Teil 2: Bedarfsgerechte Datenerfassung und -aufbereitung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-2).
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019c): Merkblatt DWA-M 543-3 Geodaten in de Fließgewässermodellierung - Teil 3: Aspekte der Strömungsmodellierung und Fallbeispiele. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-3).
	Hervouet, Jean-Michel (2007): Hydrodynamics of free surface flows. Modelling with the finite element method. Chichester: Wiley Online verfügbar unter http://www.loc.gov/catdir/enhancements/fy0741/2007296953-b.html.
	IAHR (2015): Professional Specifications for Physical and Numerical Studies in Environmental Hydraulics. In: Hydrolink (3/2015), 5 90-92.
	Olsen, Nils Reidar B. (2012): Numerical Modelling and Hydraulics. 3. Aufl. Department of Hydraulic and Environmental Engineering The Norwegian University of Science and Technology.
	Szymkiewicz, Romuald (2010): Numerical modeling in open channel hydraulics. Dordrecht: Springer (Water science an technology library, 83).
	van Waveren, Harold (1999-): Good modelling practice handbook. [Utrecht], Lelystad, Den Haag: STOWA; Rijkswaterstaat-RIZA SDU, afd. SEO/RIZA [etc. distr.] (Nota, nr. 99.036).
	Zielke, Werner (Hg.) (1999): Numerische Modelle von Flüssen, Seen und Küstengewässern. Deutscher Verband fü Wasserwirtschaft und Kulturbau. Bonn: Wirtschafts- und VerlGes. Gas und Wasser (Schriftenreihe des Deutschen Verbandes fü Wasserwirtschaft und Kulturbau, 127).

Courses				
Title		Тур	Hrs/wk	СР
Biological Wastewater Treatment (I		Lecture	2	2
Biological Wastewater Treatment (I		Recitation Section (la	5	1
Advanced Wastewater Treatment (		Lecture	2 arge) 1	2
Advanced Wastewater Treatment (	•	Recitation Section (Ia	arge) I	1
Module Responsible Admission Requirements	None			
		and the key processes involved in wastewat	er treatment	
Knowledge	knowledge of wastewater management	and the key processes involved in wastewat	er treatment.	
3	After taking part successfully, students h	ave reached the following learning results		
Professional Competence	Alter taking part successiony, students i	ave reached the following learning results		
-	Students are able to outline key areas o	f the full range of treatment systems in was	to water management	s well as their mut
Knowledge		f the full range of treatment systems in was ction. They can describe relevant economic,		
	dependence for sustainable water protei	tion. They can describe relevant economic,		riactors.
Skills	Students are able to pre-design and explain the available wastewater treatment processes and the scope of their application			
	municipal and for some industrial treatm	ent plants.		
Personal Competence				
Social Competence	Social skills are not targeted in this mod	ule.		
Autonomy	Students are in a position to work on a subject and to organize their work flow independently. They can also present on th			
	subject.			
	Independent Study Time 96, Study Time	In Lecture 84		
Credit points Course achievement				
Examination				
Examination duration and				
scale	120 mm			
	Civil Engineering: Specialisation Structur	al Engineering: Elective Compulsory		
Following Curricula				
Tonowing curricula	Civil Engineering: Specialisation Coastal			
	Civil Engineering: Specialisation Water a	• • • •		
		- General Bioprocess Engineering: Elective (	Compulson	
		on Water Quality and Water Engineering: Elective		
		ing: Specialisation II. Process Engineering and		e Compulsory
		ing: Specialisation II. Energy and Environme		
		ronmental Process Engineering: Elective Cor		compulsory
	Process Engineering: Specialisation Proc		npuisory	
	Water and Environmental Engineering: S			
	• •	pecialisation Environment: Elective Compuls	sorv	
		pecialisation environment. Elective compute		

Course L0517: Biological Wastewater Treatment		
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Joachim Behrendt	
Language	DE/EN	
Cycle	SoSe	
Content	Charaterisation of Wastewater	
	Metobolism of Microorganisms	
	Kinetic of mirobiotic processes	
	Calculation of bioreactor for wastewater treatment	
	Concepts of Wastewater treatment	
	Design of WWTP	
	Excursion to a WWTP	
	Biofilms	
	Biofim Reactors	
	Anaerobic Wastewater and sldge treatment	
	resources oriented sanitation technology	
	Future challenges of wastewater treatment	
Literature	Gujer, Willi	
	Siedlungswasserwirtschaft : mit 84 Tabellen	
l		

ISBN: 3540343296 (Gb.) URL: http://www.gbv.de/dms/bs/toc/516261924.pdf URL: http://deposit.d-nb.de/cgi-bin/dokserv?
id=2842122&prov=M&dok_var=1&dok_ext=htm
Berlin [u.a.] : Springer, 2007
TUB_HH_Katalog
Henze, Mogens
Wastewater treatment : biological and chemical processes
ISBN: 3540422285 (Pp.)
Berlin [u.a.] : Springer, 2002
TUB_HH_Katalog
Imhoff, Karl (Imhoff, Klaus R.;)
Taschenbuch der Stadtentwässerung : mit 10 Tafeln
ISBN: 3486263331 ((Gb.))
München [u.a.] : Oldenbourg, 1999
TUB_HH_Katalog
Lange, Jörg (Otterpohl, Ralf; Steger-Hartmann, Thomas;)
Abwasser : Handbuch zu einer zukunftsfähigen Wasserwirtschaft
ISBN: 3980350215 (kart.) URL: http://www.gbv.de/du/services/agi/52567E5D44DA0809C12570220050BF25/000000700334
Donaueschingen-Pfohren : Mall-Beton-Verl., 2000
TUB_HH_Katalog
Mudrack, Klaus (Kunst, Sabine;)
Biologie der Abwasserreinigung : 18 Tabellen
ISBN: 382741427X URL: http://www.gbv.de/du/services/agi/94B581161B6EC747C1256E3F005A8143/420000114903
Heidelberg [u.a.] : Spektrum, Akad. Verl., 2003
TUB HH_Katalog
Tchobanoglous, George (Metcalf & Eddy, Inc., ;)
Wastewater engineering : treatment and reuse
ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk))
Boston [u.a.] : McGraw-Hill, 2003
TUB_HH_Katalog
Henze, Mogens
Activated sludge models ASM1, ASM2, ASM2d and ASM3
ISBN: 1900222248
London : IWA Publ., 2002
TUB_HH_Katalog
Kunz, Peter
Umwelt-Bioverfahrenstechnik
Vieweg, 1992
Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung für
Wasserwirtschaft, Abwasser und Abfall, ;)
Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe
aus der Abwasserbehandlung, Kleinkläranlagen ISBN: 3860682725 URL: http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf URL:
http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf
Weimar : Universitätsverl, 2006
TUB_HH_Katalog
Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall
DWA-Regelwerk
Hennef : DWA, 2004
TUB_HH_Katalog
Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;)
Fundamentals of biological wastewater treatment
ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm
Weinheim : WILEY-VCH, 2007
 TUB_HH_Katalog

Course L3122: Biological Wa	ourse L3122: Biological Wastewater Treatment	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Joachim Behrendt	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0357: Advanced Wa	stewater Treatment
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Joachim Behrendt
Language	
Cycle	SoSe
Content	Survey on advanced wastewater treatment
	reuse of reclaimed municipal wastewater
	Precipitation
	Flocculation
	Depth filtration
	Membrane Processes
	Activated carbon adsorption
	Ozonation
	"Advanced Oxidation Processes"
	Disinfection
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung,
	Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003

Course L0358: Advanced Was	stewater Treatment
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Joachim Behrendt
Language	EN
Cycle	SoSe
Content	Aggregate organic compounds (sum parameters)
	Industrial wastewater
	Processes for industrial wastewater treatment
	Precipitation
	Flocculation
	Activated carbon adsorption
	Recalcitrant organic compounds
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003

Courses	
Title	Typ Hrs/wk CP
City Planning (L1066)	Project-/problem-based Learning 4 6
Module Responsible	
Admission Requirements	None
	for "Principles of Urban Planning": none
Knowledge	for "Designing Urban Streetscapes": some knowledge of transport planning, e.g. through taking the undergraduate class "Trar
	Planning and Traffic Engineering"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
	Students are able to:
5	
	use technical terms of urban planning.
	<ul> <li>describe the main determinants of urban development.</li> <li>evaluation and compare different persibilities of how urban development can be influenced.</li> </ul>
	<ul> <li>explain and compare different possibilities of how urban development can be influenced.</li> <li>discuss requirements for public streetscapes.</li> </ul>
	<ul> <li>explain the importance of street design.</li> </ul>
Skills	Students are able to:
	e read and analyze when development concerts and designs for streetscanes
	<ul> <li>read and analyze urban development concepts and designs for streetscapes</li> <li>appraise such concepts in the context of comparing requirements</li> </ul>
	<ul> <li>appraise such concepts in the context of competing requirements.</li> <li>design, justify and reflect their own solutions for concrete examples.</li> </ul>
Personal Competence	
Social Competence	Students are able to:
	discuss intermediate results with each other.
	constructively accept feedback on their own work.
	provide constructive feedback to others.
Autonomy	Students are able to:
	<ul> <li>independently complete a written report including drawings following a broadly pre-defined process.</li> </ul>
	<ul> <li>assess the consequences of their proposed solutions.</li> </ul>
	<ul> <li>independently acquire knowledge and apply this to new issues or problem areas.</li> </ul>
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	written assignment, designwork during the semester
scale	
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Compulsory

Course L1066: City Planning	
Тур	Project-/problem-based Learning
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	SoSe
Content	<ul> <li>"Principles of Urban Planning" deals with the determinants of urban development and their interactions. Topics include: <ul> <li>legal framework,</li> <li>instruments and methods of planning,</li> <li>functional requirements,</li> <li>stakeholders and actors</li> <li>basic design requirements</li> <li>different planning levels and</li> <li>historical contexts.</li> </ul> </li> <li>The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functional and aesthetic requirements for designing streetscape as the most important elements of public space.</li> <li>The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept, a building masterplan and a street redesign.</li> </ul>
Literature	Albers, Gerd; Wekel, Julian (2021) Stadtplanung: Eine illustrierte Einführung. 4. überarbeitete Auflage. Primus Verlag. Darmstadt. Frick, Dieter (2011) Theorie des Städtebaus: Zur baulich-räumlichen Organisation von Stadt. 3. veränderte Auflage. Wasmuth Verlag. Tübingen Jonas, Carsten (2009) Die Stadt und ihr Grundriss. Wasmuth-Verlag. Tübingen Kostof, Spiro; Castillo, Greg (1998) Die Anatomie der Stadt. Geschichte städtischer Strukturen. Campus-Verlag. Frankfurt/New York.

Courses				
Title	Тур		Hrs/wk	СР
Construction Logistics (L1163)	Lectu		1	2
Construction Logistics (L1164)		ation Section (small)	1	2
Project Development and Managen		ure ect-/problem-based Learning	1	1
Project Development and Managen		ct-/problem-based Learning	1	1
Module Responsible				
Admission Requirements				
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following lea	arning results		
Professional Competence	Chuda aha ang			
Knowleage	Students can			
	• give definitions of the main terms of construction logistics and	project development and m	anagement	
	name advantages and disadvantages of internal or external con	nstruction logistics		
	• explain characteristics of products, demand and production of	construction objects and the	eir consequer	nces for constructio
	specific supply chains			
	differentiate constructions logistics from other logistics systems	5		
Skille	Students can			
JKIIIS				
	<ul> <li>carry out project life cycle assessments</li> </ul>			
	<ul> <li>apply methods and instruments of construction logistics</li> </ul>			
	<ul> <li>apply methods and instruments of project development and management</li> </ul>			
	<ul> <li>apply methods and instruments of conflict management</li> </ul>			
	<ul> <li>design supply and waste removal concepts for a construction p</li> </ul>	roject		
Personal Competence				
Social Competence	Students can			
boerar competence				
	<ul> <li>hold presentations in and for groups</li> </ul>			
	<ul> <li>apply methods of conflict solving skills in group work and case</li> </ul>	studies		
Διιτοποπγ	Students can			
hatohomy				
	<ul> <li>solve problems by holistic, systemic and flow oriented thinking</li> </ul>			
	<ul> <li>improve their creativity, negotiation skills, conflict and crises</li> </ul>	solution skills by applying	methods of	moderation in cas
	studies			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination	Written elaboration			
	Two written papers with presentations			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Comp	pulsory		
Following Curricula	Civil Engineering: Specialisation Sedecular Engineering: Elective Configuration Sedecular Engineering: Elective Co	5		
string curriculu	Civil Engineering: Specialisation Coastal Engineering: Elective Comput			
	Civil Engineering: Specialisation Water and Traffic: Elective Compulso	•		
	International Management and Engineering: Specialisation II. Civil Eng		ory	
	International Management and Engineering: Specialisation II. Logistics			
	Logistics, Infrastructure and Mobility: Specialisation Production and Lo	aistics: Elective Compulsory	/	

Course L1163: Construction	Logistics
Тур	Lecture
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig
Language	DE
Cycle	SoSe
Content	The lecture gives deeper insight how important logistics are as a competetive factor for construction projects and which issues are to be adressed. The following toppics are covered: <ul> <li>competetive factor logistics</li> <li>the concept of systems, planning and coordination of logistics</li> <li>material, equipment and reverse logistics</li> <li>IT in construction logistics</li> <li>elements of the planning model of construction logistics and their connections</li> <li>flow oriented logistics systems for construction projects</li> <li>logistics concepts for ready to use construction projects (especially procurement and waste removel logistics)</li> <li>best practice examples (construction logistics Potsdamer Platz, recent case study of the region)</li> </ul> <li>Contents of the lecture are deepened in special exercises.</li>
Literature	Flämig, Heike: Produktionslogistik in Stadtregionen. In: Forschungsverbund Ökologische Mobilität (Hrsg.) Forschungsbericht Bd 15.2. Wuppertal 2000. Krauss, Siri: Die Baulogistik in der schlüsselfertigen Ausführung, Bauwerk Verlag GmbH Berlin 2005. Lipsmeier, Klaus: Abfallkennzahlen für Neubauleistungen im Hochbau : Verlag Forum für Abfallwirtschaft und Altlasten, 2004. Schmidt, Norbert: Wettbewerbsfaktor Baulogistik. Neue Wertschöpfungspotenziale in der Baustoffversorgung. In: Klaus, Peter Edition Logistik. Band 6. Deutscher Verkehrs-Verlag. Hamburg 2003. Seemann, Y.F. (2007): Logistikkoordination als Organisationseinheit bei der Bauausführung Wissenschaftsverlag Mainz in Aachen, Aachen. (Mitteilungen aus dem Fachgebiet Baubetrieb und Bauwirtschaft (Hrsg. Kuhne, V.): Heft 20)

Course L1164: Construction	Course L1164: Construction Logistics	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Heike Flämig	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

ourse L1161: Project Development and Management		
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei	
Language	DE	
Cycle	SoSe	
Content	Within the lecture, the main aspects of project development and management are tought:	
	Terms and definitions of project management	
	<ul> <li>Advantages and disadvantages of different ways of project handling</li> </ul>	
	<ul> <li>organization, information, coordination and documentation</li> </ul>	
	cost and fincance management in projects	
	<ul> <li>time- and capacity management in projects</li> </ul>	
	<ul> <li>specific methods and instruments for successful team work</li> </ul>	
	Contents of the lecture are deepened in special exercises.	
Literature	Projektmanagement-Fachmann. Band 1 und Band 2. RKW-Verlag, Eschborn, 2004.	

Course L1162: Project Devel	rse L1162: Project Development and Management	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0998: Statio	s and Dynamics of Structure	es		
Courses				
Title		Тур	Hrs/wk	СР
Structural Dynamics (L1202)		Lecture	2	2
Structural Dynamics (L1203)		Recitation Section (large)	2	2
Fracture mechanics and fatigue in	steel structures (L0564)	Lecture	1	1
Fracture mechanics and fatigue in	steel structures (L0565)	Recitation Section (large)	1	1
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous	Knowledge of linear structural analysis	of statically determinate and indeterminate structu	ures; Mechanics	I/II, Mathematics
	Differential equations I			
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
<b>Professional Competence</b>				
Knowledge	After successful completion of this mod respective methods.	ule, the student can explain the basic aspects of d	ynamic effects c	n structures and 1
Skills	After successful completion of this mo dynamics loading using the appropriate o	odule, the students will be able to predict the res computational approaches and methods.	ponse of materi	al and structures
Personal Competence				
Social Competence	Students can			
	<ul> <li>participate in subject-specific and</li> </ul>			
	defend their own work results in fr			
	promote the scientific developmer	-		
	<ul> <li>Furthermore, they can give and ac</li> </ul>	ccept professional constructive criticism		
Autonomy	Students are able to gain knowledge of t	he subject area from given and other sources and a	oply it to new pr	oblems. Furthermo
		ocess for problems in the area of Structural Analysis.		
	Independent Study Time 96, Study Time	in Lecture 84		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	150 min			
scale				
	Civil Engineering: Specialisation Structure	al Engineering: Compulsory		
Assignment for the	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory		
Assignment for the Following Curricula				
-	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory		
-	Civil Engineering: Specialisation Coastal Civil Engineering: Specialisation Water ar			
-		nd Traffic: Elective Compulsory		

Course L1202: Structural Dy	namics	
Тур	Lecture	
Hrs/wk		
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>mechanical background of dynamics</li> <li>harmonic vibrations, damped and undamped free and forced vibrations</li> <li>frequency and time domain</li> <li>modelling aspects</li> <li>principle of d'Alembert</li> <li>systems with multiple degrees of freedom</li> <li>consistent and lumped mass matrices</li> <li>finite elements for dynamics problems</li> <li>impact problems</li> <li>eigenvalue problems and modal analysis</li> <li>direct time integration schemes, transient analyses</li> </ul>	
Literature	<ul> <li>Vorlesungsmanuskript</li> <li>Clough, R.W., Penzien, J.: Dynamics of Structures. 2. Aufl., McGraw-Hill, New York, 1993.</li> </ul>	

Course L1203: Structural Dy	ourse L1203: Structural Dynamics	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Тур	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Jürgen Priebe
Language	DE
Cycle	SoSe
Content	<ul> <li>basics of fatigue stress and fatigue resistance and determination of fatigue strength,</li> </ul>
	determination and use of S-N-curves and classification of notch effects,
	• set up of determination of fatigue strength under dynamic load using the accumulation formula by Palmgren-Miner,
	set up of determination of fatigue strength in different examples,
	<ul> <li>basics of construction and design regarding the problem of material fatigue,</li> </ul>
	basics of linear elastic fracture mechanics under static and dynamic load,
	determination of lifetime of steel construction based on linear elastic fracture mechanics in different examples.
Literature	Seeßelberg, C.; Kranbahnen - Bemessung und konstruktive Gestaltung; 3. Auflage; Bauwerk-Verlag; Berlin 2009
	• Kuhlmann, Dürr, Günther; Kranbahnen und Betriebsfestigkeit; in Stahlbau Kalender 2003; Verlag Ernst & Sohn; Berlin 2003
	Deutscher Stahlbau-Verband (Hrsg.); Stahlbau Handbuch Band 1 Teil B; 3. Auflage; Stahlbau-Verlagsgesellschaft; Köln 199
	Petersen, C.; Stahlbau; 3. überarb. und erw. Auflage; Vieweg-Verlag; Braunschweig 1993
	<ul> <li>DIN V ENV 1993-1-1: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 1-1: Allgemeine Bemessungsree Bemessungsregeln für den Hochbau; 1993</li> </ul>
	• DIN V ENV 1993-6: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 6: Kranbahnen; 2001
	DIN-Fachbericht 126. Richtlinie zur Anwendung von DIN V ENV 1993-6; Nationales Anwendungsdokument (NAD); Berlin 20

Course L0565: Fracture mechanics and fatigue in steel structures	
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Jürgen Priebe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Гitle		Тур	Hrs/wk	СР
Steel Construction Project (L1206)		Project Seminar	4	6
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
<b>Recommended Previous</b>	Steel and Composite Structures			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Students are able to prepare a part of the	whole project and explain it to the others.		
Skills	5 Students can produce sketches and calculations of their part of the project. They are able to adjust their work in reaction			
	changing conditions resulting from other p	participants of the project.		
Personal Competence				
Social Competence	Students can present their results to othe	r members of the group.		
	They have the ability to work for a broad a	agreement with respect to intergroup depende	encies.	
	They can distribute and process tasks inde	ependently.		
Autonomy	Students can handle their part of the proje	ect on their own resposibility-		
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	approx. 15-20 pages (without appendix)			
scale				
Assignment for the	Civil Engineering: Specialisation Geotechn	ical Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal E	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Structura			
	Civil Engineering: Specialisation Computation	ional Engineering: Elective Compulsory		

Course L1206: Steel Construction Project	
Тур	Project Seminar
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	Design of a big construction project (i.e skyscraper, large bridge, roof of a stadiuim) in small groups
Literature	Wird je nach Projekt individuell angegeben.

Courses				
Title		Тур	Hrs/wk	СР
Marine Geotechnics (L0548)		Lecture	1	2
Marine Geotechnics (L0549)		Recitation Section (large)	2	2
Steel Structures in Foundation and Module Responsible		Lecture	Z	Z
Admission Requirements				
	Complete modules: Geotechnics I-III, Math	ematics LIII		
Kecommended Previous Knowledge	complete modules: Geotechnics I-III, Math			
Knowledge	Courses: Soil laboratory course			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	The students get a deeper knowledge of s	steel and ground engineering as well as construct	ions knowledge co	oncerning quay wa
	Furthermore, the students get all the necessary knowledge to design singular construction elements for sheet pile walls and they			
know how to choose the right construction elements depending on the influencing conditions.				
Skille	Furthermore, the students are able to dir	nension sheet nile wall construction regarding al	l construction eler	ments to choose t
Skiiis	Furthermore, the students are able to dimension sheet pile wall construction regarding all construction elements, to choose the suitable construction elements with respect to the influencing conditions, to design all kinds of sheet pile walls (wave sheet pile			
	walls and combined sheet pile walls) and to dimension all construction elements and connections.			
Personal Competence				
Social Competence				
Autonomy	Students are able to assess their own stre	ngths and weaknesses and organize their time an	d learning manage	ement based on thi
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Geotechn	ical Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal E	ngineering: Compulsory		
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory		

Course L0548: Marine Geote	Course L0548: Marine Geotechnics	
Тур	Lecture	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Jürgen Grabe	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Geotechnical investigation an description of the seabed</li> <li>Foundations of Offshore-Constructions</li> <li>cCliff erosion</li> <li>Sea dikes</li> <li>Port structures</li> <li>Flood protection structures</li> </ul>	
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst &amp; Sohn, Berlin</li> </ul>	

## Module Manual M.Sc. "Civil Engineering"

Course L0549: Marine Geote	irse L0549: Marine Geotechnics	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Jürgen Grabe	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1146: Steel Structures in Foundation and Hydraulic Engineering		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Frank Feindt	
Language	DE	
Cycle	SoSe	
Content	Design of a sheet pile wall, design of a combined sheet pile wall, piles, walings, connections, fatigue	
Literature	EAU 2012, EA-Pfähle, EAB	

C				
Courses				
Title		Тур	Hrs/wk	СР
Smart Monitoring (L2762) Smart Monitoring (L2763)		Integrated Lecture Recitation Section (small)	2	2 4
Module Responsible	Prof. Kay Smarsly	Rectation Section (Small)	L	-
Admission Requirements	None			
Recommended Previous	Basic knowledge or interest in object-oriented mode	aling programming and concor technology	aios ara halaful	Interact in mo
Knowledge	research and teaching areas, such as Internet of Th			
j-	skills of scientific working, are required. Basic knowle			
	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	The students will become familiar with the princip			
	decentralized smart systems to be applied for co			
	environment. In addition, the students will learn to d			
	analysis techniques, modern software design concep			
	also part of this module, which will be conducted throughout the semester and will contribute to the grade. In small groups, students will design smart monitoring systems that integrate a number of "intelligent" sensors to be implemented by the stude			
	Specific focus will be put on the application of machine learning techniques. The smart monitoring systems will be mounted			
	real-world (built or natural) systems, such as bridges or slopes, or on scaled lab structures for validation purposes. The outcome			
	every group will be documented in a paper. All stude			
	system in the annual "Smart Monitoring" competition			
	will be taught in English. Limited enrollment.			5
Skills	The students will gain insights into operating state-o	of-the-art smart sensor systems, used for	monitoring a wi	de range of phy
	processes relevant to engineering, such as environ	nmental, structural, or comfort monitori	ng. The students	s will be capabl
	devising monitoring strategies of physical processes as part of group projects, tailored to their knowledge backgrounds, and			
	implement the strategies in smart wireless sensor no	• • • •	ogramming. Fina	lly, the students
	be able to document the findings of their projects in s	short reports.		
Personal Competence				
Social Competence	tence The students will be able to work in groups, share parts of the work for their projects, and develop communication skills, to			
	achieving the common project goals.			
4				
Autonomy	The students will be able to gain a solid basis on a		ineering, as well	as on documer
	results, through their involvement in their monitoring	group projects.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
	10 pages of work with 15-minute oral presentation			
scale	Civil Engineering: Considiration Water and Traffic El			
-	Civil Engineering: Specialisation Water and Traffic: El Civil Engineering: Specialisation Geotechnical Engine			
Following Curricula	Civil Engineering: Specialisation Coastal Engineering:			
	Civil Engineering: Specialisation Structural Engineering.			
	Computer Science: Specialisation II: Intelligence Engi			
	Environmental Engineering: Specialisation Energy an			
	Environmental Engineering: Specialisation Environme			
	Environmental Engineering: Specialisation Water Quality and Water Engineering: Elective Compulsory			
	Mechatronics: Technical Complementary Course: Elec		. ,	
	Mechatronics: Core Qualification: Elective Compulsor			
	Theoretical Mechanical Engineering: Specialisation Re		ompulsory	
	Water and Environmental Engineering: Specialisation		. ,	
	Water and Environmental Engineering: Specialisation	Environment: Elective Compulsory		

Course L2762: Smart Monito	Course L2762: Smart Monitoring		
Тур	Integrated Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Kay Smarsly		
Language	EN		
Cycle	SoSe		
Content	In this course, principles of smart monitoring will be taught, focusing on modern concepts of data acquisition, data storage, and data analysis. Also, fundamentals of intelligent sensors and embedded computing will be illuminated. Autonomous software and decentralized data processing are further crucial parts of the course, including concepts of the Internet of Things, Industry 4.0 and cyber-physical systems. Furthermore, measuring principles, data acquisition systems, data management and data analysis algorithms will be discussed. Besides the theoretical background, numerous practical examples will be shown to demonstrate how smart monitoring may advantageously be used for assessing the condition of systems in the built or natural environment.		
Literature	The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course. However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online.		

ourse L2763: Smart Monitoring		
	Recitation Section (small)	
Hrs/wk		
СР	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Lecturer	Prof. Kay Smarsly	
Language	EN	
Cycle	SoSe	
	The contents of the exercises are based on the lecture contents. In addition to the exercises, project work will be conducted throughout the semester, which will consume the majority of the workload. As part of the project work, students will design smart monitoring systems that will be tested in the laboratory or in the field. As mentioned in the module description, the students will participate in the "Smart Monitoring" competition, hosted annually by the Institute of Digital and Autonomous Construction. Students are encouraged to contribute their own ideas. The tools required to implement the smart monitoring systems will be taught in the group exercises as well as through external sources, such as video tutorials and literature. The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course.	
	However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online.	

Module M1845: Thin-	walled structures				
Courses					
Title		Тур	Hrs/wk	СР	
Thin-walled structures (L1199)		Lecture	2	3	
Thin-walled structures (L3045)		Recitation Section (large)	2	3	
Module Responsible	Prof. Bastian Oesterle				
Admission Requirements	None				
<b>Recommended Previous</b>					
Knowledge					
	Structural Analysis II				
	Finite Element Methods				
Educational Objectives	After taking part successfully, students have read	ched the following learning results			
Professional Competence					
Knowledge	After successful completion of this module, the	students can express the basic aspects of	the load-carryin	g behaviour of thi	
	walled structures.				
<i>CL 11</i>		and the second		· · · · · · · · · · · · · · · · · · ·	
Skills	After successful completion of this module, the		g benaviour of th	nin-walled structure	
	using appropriate analytical and coputational me	thods.			
Personal Competence					
Social Competence	Students can				
	<ul> <li>participate in subject-specific and interdisc</li> </ul>	ciplinary discussions,			
	• defend their own work results in front of o	thers			
	<ul> <li>promote the scientific development of coll</li> </ul>	eagues			
	<ul> <li>Furthermore, they can give and accept pro</li> </ul>	•			
Autonomy	Students are able to gain knowledge of the subje	-			
	they are able to structure the solution process fo	r problems in the area of modelling and analy	sis of thin-walled	d structures.	
Workload in Hours	Independent Study Time 124, Study Time in Lect	ure 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	Civil Engineering: Specialisation Coastal Engineer	ring: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng	gineering: Elective Compulsory			
	Civil Engineering: Specialisation Computational E	ngineering: Compulsory			
	Civil Engineering: Specialisation Structural Engine	eering: Elective Compulsory			
	Theoretical Mechanical Engineering: Specialisatic	on Simulation Technology: Elective Compulso	ry		

Тур	Lecture
Hrs/wk	
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	Plates loaded in-plane
	Governing equations (equilibrium, kinematics, constitutive law)
	Differential equation
	Airy stress function
	Plane stress / plane strain
	Structural behaviour of plates loaded in-plane
	<ul> <li>finite elements for plates loaded in-plane, modelling apsects, interpretation and critical assessment of results</li> </ul>
	Plates in bending
	Governing equations (equilibrium, kinematics, constitutive law)
	Differential equation
	Navier solution / Fourier series expansion
	Approximation procedures
	Circular and rectangular plates
	Structural behaviour of plates in bending
	<ul> <li>finite elements for plates in bending, modelling apsects, interpretation and critical assessment of results</li> </ul>
	Shells
	Phenomenona of the structural behaviour of shells
	Membrane and bending theory
	Equilibrium equations of shells of revolution
	<ul> <li>Stress resultants and deformations of the spherical shell, the half spherical shell, and the cylindrical shell</li> </ul>
	finite elements for shells
	Stability problems (overview)
	Plate buckling     Chall buckling
	Shell buckling
Literature	Vorlesungsmanuskript
	<ul> <li>Vollesungsmanuskript</li> <li>Basar, Y.: Krätzig, W.B. (1985): Mechanik der Flächentragwerke. Vieweg-Verlag, Braunschweig, Wiesbaden</li> </ul>
	Girkmann, K. (1963): Flächentragwerke, Springer Verlag, Wien, 1963, unveränderter Nachdruck 1986     Zienkiewicz, O.C. (1977): The Einite Element Mathed in Engineering Science, McGraw Hill, London
	• Zienkiewicz, O.C. (1977): The Finite Element Method in Enginieering Science. McGraw-Hill, London

Course L3045: Thin-walled st	ourse L3045: Thin-walled structures	
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Offshore Geotechnical Engineering	(L0067)	Lecture	1	1
Hydro Power Use (L0013)		Lecture	1	1
Wind Turbine Plants (L0011)	10012)	Lecture	2	3
Nind Energy Use - Focus Offshore		Lecture	1	1
	Dr. Marvin Scherzinger			
Admission Requirements				
Kecommended Previous Knowledge	Module: Technical Thermodynamics I,			
Knowledge	Module: Technical Thermodynamics II,			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
	By ending this module students can explain i	n detail knowledge of wind turbines w	vith a particular focus o	f wind energy use
, and the second s	offshore conditions and can critical comment t	•		•••
	to describe fundamentally the use of water pow			
	in the implementation of renewable energy pro	• •		
	Through active discussions of various topics			derstanding and
	application of the theoretical background and a	are thus able to transfer what they hav	e learned in practice.	
Skills	Students are able to apply the acquired theo	retical foundations on exemplary wat	er or wind power syster	ns and evaluate
	assess technically the resulting relationships in			
	compare critically the special procedure for the	e implementation of renewable energy	projects in countries ou	tside Europe with
	in principle applied approach in Europe and car	apply this procedure on exemplary th	eoretical projects.	
Dersenal Competence				
Personal Competence Social Competence	Students can discuss scientific tasks subjet-sp	ecificly and multidisciplinary within a s	eminar	
Social competence				
Autonomy	Students can independently exploit sources in	n the context of the emphasis of the	lecture material to clea	r the contents of
	lecture and to acquire the particular knowledge	e about the subject area.		
Workload in Hours	Independent Study Time 110, Study Time in Le	cture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engi	ineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical E	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engine	ering: Elective Compulsory		
	International Management and Engineering: Sp	ecialisation II. Energy and Environmen	tal Engineering: Elective	Compulsory
	International Management and Engineering: Sp	ecialisation II. Renewable Energy: Elec	tive Compulsory	
	Product Development, Materials and Production			
	Product Development, Materials and Production	•		
	Product Development, Materials and Production		mpulsory	
	Renewable Energies: Core Qualification: Compu	•		
	Theoretical Mechanical Engineering: Specialisa			
	Process Engineering: Specialisation Environmen		pulsory	
	Water and Environmental Engineering: Speciali	sation Cities: Elective Compulsory		
	Water and Environmental Engineering: Speciali Water and Environmental Engineering: Speciali	sation Environment: Elective Compulso	ory	

ourse L0067: Offshore Geotechnical Engineering			
Тур	ecture		
Hrs/wk			
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Dr. Jan Dührkop		
Language	DE		
Cycle	SoSe		
Content	<ul> <li>Overview and Introduction Offshore Geotechnics</li> <li>Introduction to Soil Mechanics</li> <li>Offshore soil investigation</li> <li>Focus on cyclical effects</li> <li>Geotechnical design of offshore foundations</li> <li>Monopiles</li> <li>Jackets</li> <li>Heavyweight foundations</li> <li>Geotechnical preliminary exploration for the use of lift boats and platforms</li> </ul>		
Literature	<ul> <li>Randolph, M. and Gourvenec, S (2011): Offshore Geotechnical Engineering. Spon Press.</li> <li>Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>BSH-Standard Baugrunderkundung für Offshore-Windenergieparks</li> <li>Lesny K. (2010): Foundations for Offshore Wind Turbines. VGE Verlag, Essen.</li> <li>EA-Pfähle (2012): Empfehlungen des Arbeitskreises Pfähle der DGGT. Ernst &amp; Sohn, Berlin.</li> </ul>		

Course L0013: Hydro Power	Use
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Achleitner
Language	DE
Cycle	SoSe
Content	<ul> <li>Introduction, importance of water power in the national and global context</li> <li>Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies</li> <li>Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems</li> <li>Construction of hydroelectric power plants: description of the individual components and their technical system interaction</li> <li>Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc.</li> <li>Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection</li> <li>Hydropower and the Environment</li> <li>Examples from practice</li> </ul>
Literature	<ul> <li>Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage</li> <li>Quaschning, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage</li> <li>Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage</li> <li>von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage</li> <li>Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006</li> </ul>

Course L0011: Wind Turbine	Plants	
Тур	cture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Rudolf Zellermann	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Historical development</li> <li>Wind: origins, geographic and temporal distribution, locations</li> <li>Power coefficient, rotor thrust</li> <li>Aerodynamics of the rotor</li> <li>Operating performance</li> <li>Power limitation, partial load, pitch and stall control</li> <li>Plant selection, yield prediction, economy</li> <li>Excursion</li> </ul>	
Literature	Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005	

Course L0012: Wind Energy	Use - Focus Offshore
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Skiba
Language	DE
Cycle	SoSe
Content	<ul> <li>Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering</li> <li>Physical fundamentals for utilization of wind energy</li> <li>Design and operation of offshore wind turbines, presentation of different concepts of offshore wind turbines, representation of the individual system components and their system-technical relationships</li> <li>Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures</li> <li>Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection</li> <li>Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics</li> <li>Development and planning of offshore wind farms</li> <li>Operation and optimization of offshore wind farms</li> <li>Day excursion</li> </ul>
Literature	<ul> <li>Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage</li> <li>Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidel-berg, 1997, 3. Auflage</li> <li>Hau, E.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage</li> <li>Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage</li> <li>Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage</li> </ul>

Module M0858: Coas	tal Hydraulic Engineering I			
Courses				
Title		Тур	Hrs/wk	СР
Basics of Coastal Engineering (L08		Lecture	3	4
Basics of Coastal Engineering (L14		Project-/problem-based Learni	ng 1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Basics of hydraulic engineering, hydrology	and hydromechanics		
Knowledge				
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	The students are able to define and explai	n the basic concepts of coastal engineering and po	rt engineering. T	hey are able to app
		ns of coastal engineering. Students can define and	I determine the I	basics for design a
	dimensioning of coastal engineering const	ructions.		
Skills	The students are capable to apply basic design approaches to selected and pre-defined design tasks in coastal engineering.			
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in applied problems such as the design of coastal protection structur			
	Additionaly, they will be able to work in tea	am with engineers of other disciplines, for instance	designing of coa	stal breakwaters.
Autonomy	The students will be able to independently	extend their knowledge and applyit to new problem	ms.	
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 2 hou	urs. The examination includes tasks with respect	to the general u	understanding of t
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Coastal Er	ngineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechni	ical Engineering: Compulsory		
	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory		
	Environmental Engineering: Specialisation	Environment and Climate: Elective Compulsory		
	Environmental Engineering: Specialisation	Water Quality and Water Engineering: Elective Cor	npulsory	
	International Management and Engineering	g: Specialisation II. Civil Engineering: Elective Comp	oulsory	
	• • •	ecialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Spe	ecialisation Water: Elective Compulsory		

Course L0807: Basics of Coastal Engineering		
Тур	Lecture	
Hrs/wk	3	
CP	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Peter Fröhle	
Language	EN	
Cycle	SoSe	
Content		
	Basics of planning and design	
	Water levels     Currents	
	Waves	
	• lce	
	Planning and Design in Coastal Engineering	
	Functional and constructional design	
	<ul> <li>Determination of design parameters</li> </ul>	
	• Design-approaches	
	■ Filter	
	<ul> <li>Rubble mound constructions</li> </ul>	
	Piles	
	<ul> <li>Vertical constructions</li> </ul>	
Literature	Coastal Engineering Manual, CEM	
	Vorlesungsumdruck	
	i vonesungsunnuruck	
L		

Course L1413: Basics of Coas	stal Engineering
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Turn	Line /usiz	CD
Water Protection and Wastewater	Aanagement (10226)	<b>Typ</b> Lecture	Hrs/wk 3	<b>СР</b> 3
Water Protection and Wastewater	-	Project Seminar	3	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge	Basic knowledge in water managemen	t;		
	<ul> <li>Good knowledge in urban drainage;</li> <li>Good knowledge of wastewater treatm</li> </ul>	ont tochniquoci		
	<ul> <li>Good knowledge of pollutants (e.g. CO</li> </ul>			
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	The students can describe the basic principle	• •		•
	They can explain limnological processes, su			
	problems related to water protection, such		atment with a special	focus on innovati
	solutions, remediation measures as well as c	inceptual approaches.		
Skills	Students can accurately assess current prob	lems and situations in a country-specific or	local context. They o	can suggest concre
	actions to contribute to the planning of to	morrow's urban water cycle. Furthermore,	they can suggest a	ppropriate technic
	administrative and legislative solutions to sol	ve these problems.		
Personal Competence				
	The students can work together in internation	nal groups.		
,	5	5		
<b>4 1 1 1 1 1</b>			-	
Autonomy	Students are able to organize their work flow	v to prepare presentations and discussions	. They can acquire ap	propriate knowled
	by making enquiries independently.			
Workload in Hours	Independent Study Time 96, Study Time in L	ecture 84		
Credit points				
Course achievement				
Examination	Presentation			
Examination duration and	Term paper plus presentation			
scale				
	Civil Engineering: Specialisation Structural Er	5 5 1 5		
Following Curricula	Civil Engineering: Specialisation Geotechnica Civil Engineering: Specialisation Coastal Engi			
	Civil Engineering: Specialisation Coastal Engi Civil Engineering: Specialisation Water and T			
	Environmental Engineering: Specialisation Water and T		e Compulsory	
	International Management and Engineering:			
	Water and Environmental Engineering: Speci			
	Water and Environmental Engineering: Speci			
	Water and Environmental Engineering: Speci			

Course L0226: Water Protect	tion and Wastewater Management
Тур	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
	<ul> <li>The lecture focusses on:</li> <li>Regulatory Framework (e.g. WFD)</li> <li>Main instruments for the water management and protection</li> <li>In depth knowledge of relevant measures of water pollution control</li> <li>Urban drainage, treatment options in different regions on the world</li> <li>Rainwater management, improved management of heavy rainfalls, downpours, rainwater harvesting, rainwater infiltration</li> <li>Case Studies and Field Trips</li> </ul>
Literature	<ul> <li>The literature listed below is available in the library of the TUHH.</li> <li>Water and wastewater technology Hammer, M. J. 1., &amp; . (2012). (7. ed., internat. ed.). Boston [u.a.]: Pearson Education International.</li> <li>Water and wastewater engineering : design principles and practice: Davis, M. L. 1. (2011). New York, NY: McGraw-Hill.</li> <li>Biological wastewater treatment: (2011). C. P. Leslie Grady, Jr. (3. ed.). London, Boca Raton, Fla. [u.a.]: IWA Publ.</li> </ul>

Course L2008: Water Protect	ourse L2008: Water Protection and Wastewater Management	
Тур	Project Seminar	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	WiSe	
Content		
Literature		

Courses				
Title		Тур	Hrs/wk	СР
Examination of Materials, Structura	-	Lecture	3	4
Examination of Materials, Structura		Recitation Section (small)	1	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge about building materials or ma	aterial science, for example by the mod	ule Building Ma	terials and Buildin
Knowledge	Chemistry.			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	The students are able to describe the rules for tra methods for the testing of building material proper testing methods.	• • •		
Skills	The students are able to responsibly discover the rules for trading and using of building products in Germany. They are able to chose suitable methods for the testing and inspection of construction products, the examination of damages the examination of the structural conditions of buildings. They are able to conclude from symptons to the cause of damages. T are able to describe an examination in form of a test report or expert opinion.			-
Personal Competence	The students can describe the different roles of m	anufacturers as well as testing supervisor	v and certificati	on bodies within t
Social competence	framework of material testing. They can describe th	÷ .	-	
Autonomy	The students are able to make the timing and the o	peration steps to learn the specialist knowl	edge of a very e	xtensive field.
Workload in Hours	Independent Study Time 124, Study Time in Lectur	e 56		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Enginee	ring: Elective Compulsory		
Following Curricula				
-	Civil Engineering: Specialisation Coastal Engineerin	g: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic:	Elective Compulsory		
	International Management and Engineering: Specia	lisation II. Civil Engineering: Elective Comp	ulsory	
	Materials Science and Engineering: Specialisation E	ngineering Materials: Elective Compulsory		
	Materials Science: Specialisation Engineering Mater	rials: Elective Compulsory		

Course L0260: Examination of	of Materials, Structural Condition and Damages
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	WiSe
Content	Materials testing and marking process of construction products, testing methods for building materials and structures, testing
	reports and expert opinions, describing the condition of a structure, from symptons to the cause of damages
Literature	Frank Schmidt-Döhl: Materialprüfung im Bauwesen. Fraunhofer irb-Verlag, Stuttgart, 2013.

Course L0261: Examination of	Course L0261: Examination of Materials, Structural Condition and Damages	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

		25				
Courses						
litle .			т	Тур	Hrs/wk	СР
Concrete Structures (L0579)				Seminar	1	1
Structural Concrete Members (L05	(7)		L	ecture	2	3
Structural Concrete Members (L05	/8)		R	ecitation Section (large)	2	2
Module Responsible	NN					
Admission Requirements	None					
<b>Recommended Previous</b>	Basics of structural	analysis, conception a	nd dimensioning of struc	tural concrete		
Knowledge						
	Modules: Reinforced	d Concrete Structures I	+II, Structural Analysis I-	+II, Mechanics I+II		
Educational Objectives	After taking part su	iccessfully students ha	ve reached the following	learning results		
Professional Competence	, iter taking part ba	iecessiany, stadents na	ie reached the following	i carring results		
	The students broad	lon their skills in struct		ally in the field of buildings	(houses roofs ha	alls) They dispose
Knowledge						
	the knowledge for the conception and design of concrete buildings and structural members that are often used.					
Skills	The students are able to apply procedures of the conception and dimensioning to to practical problems of structural engineering					
	They are capable to draft concrete buildings and to design them for general action effects and to plan their detailing and					
	execution. Moreover, they can make design and construction sketches and draw up technical descriptions.					
Demonal Commetence						
Personal Competence						
Social Competence	The students are ab	Die to obtain results of .	nigh quality in teamwork			
				sioning tasks of structures	under the guidance	e of tutors.
Autonomy	The students are ab	ble to carry out comple:	x conception and dimens		under the guidand	e of tutors.
Autonomy	The students are ab		x conception and dimens		under the guidanc	e of tutors.
Autonomy	The students are ab Independent Study 6	ble to carry out comple: Time 110, Study Time	x conception and dimens		under the guidanc	e of tutors.
Autonomy Workload in Hours	The students are ab Independent Study 6 Compulsory Bonus	ble to carry out comple: Time 110, Study Time Form	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement	The students are ab Independent Study 6 Compulsory Bonus No None	ble to carry out comple: Time 110, Study Time	x conception and dimens in Lecture 70 Description		under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination	The students are ab Independent Study 6 Compulsory Bonus No None Written exam	ble to carry out comple: Time 110, Study Time Form	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidanc	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and	The students are ab Independent Study 6 Compulsory Bonus No None Written exam	ble to carry out comple: Time 110, Study Time Form	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidanc	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination	The students are ab Independent Study 6 Compulsory Bonus No None Written exam	ble to carry out comple: Time 110, Study Time Form	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes	ble to carry out comple: Time 110, Study Time Form Presentation	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp	ble to carry out comple: Time 110, Study Time Form Presentation Specialisation Structural	x conception and dimens in Lecture 70 Description Es werden 2 Re	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp	ble to carry out comple: Time 110, Study Time Form Presentation Specialisation Structural Specialisation Geotechn	x conception and dimens in Lecture 70 Description Es werden 2 Re Engineering: Compulsor	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp	ble to carry out comple: Time 110, Study Time Form Presentation Specialisation Structural Specialisation Geotechn Specialisation Coastal En	x conception and dimens in Lecture 70 Description Es werden 2 Re Engineering: Compulsor ical Engineering: Elective	sioning tasks of structures eferate ausgegeben ry e Compulsory ipulsory	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp	ble to carry out complex Time 110, Study Time Form Presentation Specialisation Structural Specialisation Geotechn Specialisation Coastal Er Specialisation Water and	x conception and dimens in Lecture 70 Description Es werden 2 Re Engineering: Compulsor ical Engineering: Elective ngineering: Elective Com	sioning tasks of structures eferate ausgegeben ry e Compulsory ipulsory lsory	under the guidand	e of tutors.

Course L0579: Concrete Stru	ictures
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	NN
Language	DE
Cycle	WiSe
Content	With help of a project teamwork the subjects of the course "Concrete Structures" is practiced, discussed and presented.
Literature	- Projektbezogene Unterlagen werden abgegeben.

Course L0578: Structural Co	ncrete Members
Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	NN
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses					
Title		Тур	Hrs/wk	СР	
Chemistry of Drinking Water Treatr	nent (L0311)	Lecture	2	1	
Chemistry of Drinking Water Treatr	nent (L0312)	Recitation Section (large)	1	2	
Water Resource Management (L04)		Lecture	2	2	
Water Resource Management (L04)		Recitation Section (small)	1	1	
Module Responsible					
Admission Requirements	None				
Recommended Previous	Knowledge of water management and the	e key processes involved in water treatment.			
Knowledge					
	After taking part successfully, students ha	ave reached the following learning results			
Professional Competence	Students will be able to outline key area	as of conflict in water management, as well as t	heir mutual denas	dence for custoin	
	water supply. They will understand relevant economic, environmental and social factors. Students will be able to explain outline the organisational structures of water companies. They will be able to explain the available water treatment processes the scope of their application.				
Skills	Students will be able to assess complex problems in drinking water production and establish solutions involving wa management and technical measures. They will be able to assess the evaluation methods that can be used for this. Students be able to carry out chemical calculations for selected treatment processes and apply generally accepted technical rules a standards to these processes.				
Personal Competence					
Social Competence	Working in a diverse group of specialists	, students will be able to develop and document	complex solutions	for the managem	
	and treatment of drinking water. They v	vill be able to take an appropriate professional	position, for examp	ole representing ι	
	interests. They will be able to develop join	nt solutions in teams of diverse experts and prese	ent these solutions t	to others.	
Autonomy	Students will be in a position to work on a	a subject independently and present on this subje	ect.		
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	60 min (chemistry) + presentation				
scale					
Assignment for the	Civil Engineering: Specialisation Structure	al Engineering: Elective Compulsory			
Following Curricula					
	Civil Engineering: Specialisation Water and Traffic: Compulsory				
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory				
	Process Engineering: Specialisation Enviro	onmental Process Engineering: Elective Compulso	ory		
	Process Engineering: Specialisation Proce	ess Engineering: Elective Compulsory			
	Water and Environmental Engineering: Sp	pecialisation Water: Compulsory			
	Water and Environmental Engineering, Cr				
	water and Environmental Engineering: Sp	pecialisation Environment: Elective Compulsory			

Course L0311: Chemistry of	Drinking Water Treatment
	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Klaus Johannsen
Language	DE
Cycle	WiSe
Content	The topic of this course is water chemistry with respect to drinking water treatment and water distribution
	Major topics are solubility of gases, carbonic acid system and calcium carbonate, blending, softening, redox processes, materials and legal requirements on drinking water treatment. Focus is put on generally accepted rules of technology (DVGW- and DIN- standards). Special emphasis is put on calculations using realistic analysis data (e.g. calculation of pH or calcium carbonate dissolution potential) in exercises. Students can get a feedback and gain extra points for exam by solving problems for homework. Knowledge of drinking water treatment processes is vital for this lecture. Therefore the most important processes are explained coordinated with the course " Water resources management" in the beginning of the semester.
Literature	<ul> <li>MHW (rev. by Crittenden, J. et al.): Water treatment principles and design. John Wiley &amp; Sons, Hoboken, 2005.</li> <li>Stumm, W., Morgan, J.J.: Aquatic chemistry. John Wiley &amp; Sons, New York, 1996.</li> <li>DVGW (Hrsg.): Wasseraufbereitung - Grundlagen und Verfahren. Oldenbourg Industrie Verlag, München, 2004.</li> <li>Jensen, J. N.: A Problem Solving Approach to Aquatic Chemistry. John Wiley &amp; Sons, Inc., New York, 2003.</li> </ul>

Course L0312: Chemistry of Drinking Water Treatment		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Dr. Klaus Johannsen	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0402: Water Resour	rce Management
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Mathias Ernst
Language	DE
Cycle	WiSe
Content	The lecture provides comprehensive knowledge on interaction of water ressource management and drinking water supply. Content
	<ul> <li>overview:</li> <li>Current situation of global water resources</li> <li>User and Stakeholder conflicts</li> <li>Wasserressourcenmanagement in urbane Gebieten</li> <li>Rechtliche Aspekte, Organisationsformen Trinkwasserversorgungsunternehmen.</li> <li>Ökobilanzierung, Benchmarking in der Wasserversorgung</li> </ul>
Literature	<ul> <li>Aktuelle UN World Water Development Reports</li> <li>Branchenbild der deutschen Wasserwirtschaft, VKU (2011)</li> <li>Aktuelle Artikel wissenschaftlicher Zeitschriften</li> <li>Ppt der Vorlesung</li> </ul>

Course L0403: Water Resour	urse L0403: Water Resource Management		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Mathias Ernst		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title	Тур		Hrs/wk	СР
Integrated Transportation Planning		-/problem-based Learning	4	6
Module Responsible	Prof. Carsten Gertz			
Admission Requirements	None			
<b>Recommended Previous</b>	some knowledge of transport planning, e.g. through taking the undergra	aduate class "Transport Pl	anning and T	raffic Engineerin
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learn	ning results		
Professional Competence				
Knowledge	Students are able to:			
	describe interdependencies between land-use/location choice and	d transportation/mobility ł	pehaviour	
	explain and evaluate the social, ecological and economic effects			res.
	relate current issues in the area of integrated transport planning	and formulate an opinion	on them.	
Skills	Students are able to:			
	quantify important parameters, which influence travel demand or	are influenced by it.		
	<ul> <li>comprehensively examine a pre-defined or self-selected topic from</li> </ul>		es perspectiv	e and document t
	results in accordance with scientific conventions.			
Personal Competence				
Social Competence	Students are able to:			
	<ul> <li>provide feedback on topical contents and their teaching.</li> </ul>			
	<ul> <li>constructively handle feedback on their own work.</li> </ul>			
	<ul> <li>produce results in group work and document these.</li> </ul>			
Autonomy	Students are able to:			
	assess potential consequences of their future professional activiti	es		
	<ul> <li>independently plan working on a pre-defined project topic, acquir</li> </ul>		ge and use ar	propriate means
	its execution.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	written assignment with presentation during the semester			
scale				
-	Civil Engineering: Specialisation Structural Engineering: Elective Compu			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Com	, ,		
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsor	ry		
	Civil Engineering: Specialisation Water and Traffic: Compulsory Logistics, Infrastructure and Mobility: Specialisation Infrastructure and M	Inhility: Elective Compute	orv	
	Water and Environmental Engineering: Specialisation Cities: Compulsory		. ,	

Course L1068: Integrated Tr	ansportation Planning
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß
Language	DE
Cycle	WiSe
	The course will provide students with an understanding of interdependencies between land-use and transportation. Specific topics include a.o.:    interactions between transport and the environment and consequent limitations  characteristics of integrated planning  complex planning processes  interdependencies of location choice and mobility behaviour  transport and land-use policies  project on current issues in transportation studies
Literature	Kutter, Eckhard (2019) Stadtstruktur und Erreichbarkeit in der postfossilen Zukunft. Erich Schmidt Verlag. Berlin. Gies, Huber u. a. (Hrsg.) (93. Ergänzung 2022) Handbuch der kommunalen Verkehrsplanung. Herbert Wichmann Verlag. Berlin, Offenbach. (Loseblattsammlung mit kontinuierlichen Ergänzungen)

Module M0963: Steel	and Composite Structures			
<b>.</b>				
Courses				
Title		Тур	Hrs/wk	СР
Steel and Composite Structures (LI		Lecture	2	2
Steel and Composite Structures (L1	205)	Recitation Section (large) Lecture	2	2
Steel Bridges (L1097) Module Responsible	Drof Marcus Dutner	Lecture	Z	Z
Admission Requirements	None			
Recommended Previous	Basics of steel construction (i.e. Steel Structures I an			
Knowledge	basics of steel construction (i.e. steel structures far			
2				
Educational Objectives	After taking part successfully, students have reached	a the following learning results		
Professional Competence				
Knowledge	After successful completition, students can			
	<ul> <li>describe the phenomenon of local buckling</li> </ul>			
	<ul> <li>explain warping torsion</li> </ul>			
	<ul> <li>illustrate the behaviour of composite structure</li> </ul>	es		
	<ul> <li>specify the principles in design of composite s</li> </ul>	sttructures		
	<ul> <li>sketch the contructions of steel and composite</li> </ul>			
		-		
Skills	After successful participation students are able to			
	<ul> <li>check stiffened and unstiffened plated structure</li> </ul>	ires		
	<ul> <li>recognize and verify warping tosion in strucur</li> </ul>	es		
	design composite structures			
	design bridges and o perform the detailing			
Developed Competence				
Personal Competence				
Social Competence				
Autonomy Workload in Hours	 Independent Study Time 96, Study Time in Lecture 8	24		
Credit points	6	<b>1</b> 4		
Course achievement				
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineeri	ng: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	• • •		
	Civil Engineering: Specialisation Coastal Engineering			
	Civil Engineering: Specialisation Water and Traffic: E			
	Civil Engineering: Specialisation Computational Engin			
	International Management and Engineering: Speciali		ulsory	
	international Management and Engineering. Special	Satish II. Civil Engineering. Elective Collip	alsol y	

Course L1204: Steel and Con	nposite Structures
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	WiSe
Content	<ul> <li>Local-buckling of plated structures</li> <li>Warping torsion</li> <li>Composite-girders, -columns, -slabs, -bridges</li> <li>Principles in composite constructions</li> <li>Bridge-design and -construction</li> </ul>
Literature	Petersen, C.: Stahlbau, 4.Auflage 2013, Springer-Vieweg Verlag Minnert, J. Wagenknecht, G.: Verbundbau-Praxis - Berechnung und Konstruktion nach Eurocode 4, 2.Auflage 2013, Bauwerk Beuth Verlag

ourse L1205: Steel and Composite Structures		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Marcus Rutner	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1097: Steel Bridges				
Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Yves Freundt			
Language				
Cycle				
Content	Lecture Contents ,Steel Bridge Construction' DrIng. Jörg Ahlgrimm			
	bi-ng. Jorg Angrinin			
	- From tendering and contracting to completion - the development of a steel bridge			
	- Contents of a bridge static - structural details, examples of analysis in detail:			
	-> effective width in regard to the longitudinal stiffeners			
	-> Bearing point, bearing stiffener			
	-> Crossbeam breakthrough, crossbeam reinforcement			
	-> Analysis of the Rib-to-Floorbeam (RF) connection (web-tooth of the floorbeam between trapezoidal shaped Ribs)			
	- Steel grades, -designation, testing methods and approval certificates			
	Nondestructive weld inspecting			
	- Corrosion protection			
	- Bridge bearing - types, format, function, dimensioning, installation			
	- Expansion Joints			
	- Oscillation of bridge hangers and cables - oscillation damper			
	- Opening bridges- Detailed reviews to different assembling procedures and - implements			
	- Selective damage events			
	Requirements: Basic knowledge in the calculation, dimensioning, and construction of structural elements and joints of constructional steelwork			
Literature				
	Herbert Schmidt, Ulrich Schulte, Rainer Zwätz, Lothar Bär:     Ausführung von Stahlbauten			
	Petersen, Christian: Stahlbau, Abschnitt Brückenbau			
	<ul> <li>Ahlgrimm, J., Lohrer, I.: Erneuerung der Eisenbahnüberführung in Fulda-Horas über die Fulda, Stahlbau 74 (2005), Heft 2, S. 114</li> </ul>			

Courses			
Title	Typ Hrs/wk CP		
Module Responsible	Dozenten des SD B		
Admission Requirements	None		
<b>Recommended Previous</b>	Subjects of the Foundation Engineering specialisation.		
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
<b>Professional Competence</b>			
Knowledge	• The students are able to demonstrate their detailed knowledge in the field of geotechnical and foundation engineering. They can exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions of science and society.		
The students can develop solving strategies and approaches for fundamental and practical problems i foundation engineering. They may apply theory based procedures and integrate safety-related, ecological, et view points of science and society.			
Skills	Scientific work techniques that are used can be described and critically reviewed. The students are able to independently select methods for the project work and to justify this choice. They can explain how the methods relate to the field of work and how the context of application has to be adjusted. General findings and furth developments may essentially be outlined.		
Personal Competence			
Social Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems f the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to the colleagues.		
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the give deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedback from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.		
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0		
Credit points	6		
Course achievement	None		
Examination	Study work		
Examination duration and scale	see FSPO		
Assignment for the	Civil Engineering: Specialisation Geotechnical Engineering: Compulsory		
Following Curricula			

## Module M0969: Selected Topics in Civil Engineering

Courses				
Title		Тур	Hrs/wk	СР
Design of Composite Bridges (L3092)		Integrated Lecture	2	3
Analysis of Offshore Structures (L1867)		Lecture	1	1
Energy Geotechnics (L3227)		Lecture	3	3
Solid Matter Process Technology fo	r Biomass (L0052)	Lecture	2	3
Forum I - Geotechnics and Construe	ction Management (L1634)	Seminar	1	1
Forum II - Geotechnics and Constru	ction Management (L1635)	Seminar	1	1
Timber Structures (L1151)		Seminar	2	2
Innovative Timber Construction (L2	666)	Lecture	2	4
Glass Structures (L1152)		Lecture	2	2
Glass Structures (L1447)		Recitation Section (large)	1	1
Sustainable landfill design and oper	ration (L3270)	Integrated Lecture	3	3
Special Topics in Steel Design (L30	91)	Integrated Lecture	2	3
Special topics of civil engineering 1	CP (L2378)		1	1
Special topics of civil engineering 2	2 LP (L2379)		2	2
Special topics of civil engineering 3	3 LP (L2380)		3	3
Structural Design (L2789)		Seminar	2	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge				
	<ul> <li>Students are able to find their way through selected special areas within civil and structural engineering.</li> </ul>			
	• Students are able to explain basic models and procedures in selected special areas of civil and structural engineering.			
	Students are able to interrelate scientific and	technical knowledge.		
Skills	<ul> <li>Students are able to apply basic methods in selected areas of civil and structural engineering.</li> </ul>			
Personal Competence				
Social Competence				
Autonomy	<ul> <li>Students can chose independently, in which courses.</li> </ul>	fields they want to deepen their knowled	dge and skills th	rough the election
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	eering: Elective Compulsory		
-	Civil Engineering: Specialisation Coastal Engineering	: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: E			
	Civil Engineering: Specialisation Computational Engin			
	ervir Engineering. Specialisation computational Engli	neering. Elective compulsory		

Course L3092: Design of Composite Bridges	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	
Literature	

## Module Manual M.Sc. "Civil Engineering"

Course L1867: Analysis of Of	
Тур	Lecture
CP Workload in Hours	1 Independent Study Time 16, Study Time in Lecture 14
Examination Form	
Examination duration and	
scale	
Lecturer	Dr. Said Fawad Mohammadi
Language	DE/EN
Cycle	SoSe
Content	Topic 1: Types of Offshore Structures, Fixed and floating structures for Oil & Gas and Offshore Wind industry
	Topic 2: Wave Forces, Morisons equation
	Topic 3: Irregular Seastates, Power spectrum and application of FFT
	Topic 4: Additional Environmental Forces, wind spectra, current forces
	Topic 5: Linear-Time-Invariant Systems, response of an LTI-system in frequency domain
	Topic 6: Tubular Welded Connections, stress concentration factors, weld geometry
	Topic 7: Introduction to Fracture Mechanics, criteria for fracture initiation and crack growth
	Topic 8: Time and Frequency Domain Fatigue Analyses, rainflow counting, application of LTI-systems for frequency domain fatigue
	Topic 9: Offshore Installation and Exam, installation of structures, pile driving, pipe laying techniques
Literature	Chakrabarti, Handbook of Offshore Engineering, 2005
	Sarpkaya, Wave Forces on Offshore Structures, 2010
	Faltinsen, Sea Loads on Ships and Offshore Structures, 1998
	Sorensen, Basic Coastal Engineering, 2006
	Dowling, Mechanical Behavior of Materials, 2007
	Haibach, Betriebsfestigkeit, 2006
	Marshall, Design of Welded Tubular Connections, 1992
	Newland, Random vibrations, spectral and wavelet analysis, 1993

Course L3227: Energy Geotechnics	
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Schriftliche Ausarbeitung (laut FPrO)
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt
scale	
Lecturer	Pauline Kaminski
Language	DE/EN
Cycle	WiSe
Content	Energy geotechnics is a young field in geotechnical engineering with the aim of developing sustainable geotechnical solutions for future-oriented issues relating to the production, transport, operation, decommissioning, and waste utilisation of various energy sources. Examples of possible fields of activity in energy geotechnics include geothermal energy and thermally activated foundation components, foundations for onshore and offshore wind turbines, the decommissioning of mining facilities and the handling of waste products from fossil fuels such as tailings and the geological storage of CO2. Relevant soil mechanical processes in these applications include the thermo-hydro-mechanically coupled behaviour of soils, multiphase flow in porous media and partially saturated soils. The lecture gives an overview of various aspects of energy geotechnics and provides in-depth knowledge of the associated soil mechanical processes. In addition, CO2-scarce geotechnical applications are discussed and emission estimates as well as the optimisation of geotechnical structures according to sustainability aspects are addressed.
Literature	

Course L0052: Solid Matter F	Process Technology for Biomass
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Prof. Werner Sitzmann
Language	DE
Cycle	SoSe
Content	The industrial application of unit operations as part of process engineering is explained by actual examples of solid biomass
	processes. Size reduction, transportation and dosing, drying and agglomeration of renewable resources are described as important
	unit operations when producing solid fuels and bioethanol, producing and refining edible oils, when making Btl - and WPC -
	products. Aspects of explosion protection and plant design complete the lecture.
Literature	Kaltschmitt M., Hartmann H. (Hrsg.): Energie aus Bioamsse, Springer Verlag, 2001, ISBN 3-540-64853-4
	Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz, Schriftenreihe Nachwachsende Rohstoffe,
	Fachagentur Nachwachsende Rohstoffe e.V. www.nachwachsende-rohstoffe.de
	Bockisch M.: Nahrungsfette und -öle, Ulmer Verlag, 1993, ISBN 380000158175

Course L1634: Forum I - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1635: Forum II - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1151: Timber Structures	
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and	90 min
scale	
Lecturer	Prof. Torsten Faber
Language	DE
Cycle	WiSe
Content	
Literature	

Course L2666: Innovative Timber Construction	
Тур	Lecture
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and	45 Minuten
scale	
Lecturer	Dr. Andreas Meisel
Language	DE
Cycle	WiSe
Content	
Literature	- Blass, J.: "Ingenieurholzbau"
	- Schickhofer, G.: "BSPhandbuch: Holz-Massivbauweise in Brettsperrholz"
	- Informationsdienst Holz: div. Merkblätter und Broschüren
	- Wallner-Novak M.: Brettsperrholz Bemessung, Band 1 und 2
	- Gerner M.: "Fachwerk: Entwicklung, Instandsetzung, Neubau"
	- Meisel, A.: "Historische Dachwerke: Beurteilung, realitätsnahe statische Analyse und Instandsetzung"
	- Kempe K.: "Dokumentation Holzschädlinge"
	- Huckfeldt T.: "Hausfäule- und Bauholzpilze"

Course L1152: Glass Structures	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	
Cycle	WiSe
Content	Glass structures
	- Introduction of the material glass (production, refinement, material characteristic)
	- design of facades
	- facade types
	- static calculation of glazing
	- static calculation of facades
	- load bearing behavior of glazing (plate or membrane stiffness)
	- vertical / horizontal glazing with safety-related requirements
	- glass structures
	- fire safety of glass facades
	- construction physics of facades and glazing
Literature	

Course L1447: Glass Structures	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L3270: Sustainable la	andfill design and operation
Тур	Integrated Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Dr. Marco Ritzkowski
Language	EN
Cycle	SoSe
Content	The course introduces the development of modern waste resource management and demonstrates the importance of landfills in the context of recycling processes. Based on international (EU) and national legislation, the current landfill situation is presented and the future significance of landfills will be discussed. A central element of the course deals with the main transformation processes in the landfilled waste, the emission of gases and leachate, the long-term behaviour of landfills as well as aftercare and after-utilisation measures. Further focal points of the course are measures for the sustainable reduction of environmentally and climate-damaging emissions and aspects of landfill technology in an international context.
Literature	<ol> <li>Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105, Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305</li> <li>Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332</li> <li>Solid Waste Landfilling - Concepts, Processes, Technologies. Cossu, R. and Stegmann, R. (Eds.), ISBN: 978-0-12-818336-6</li> <li>PDF (Volltext) über TUB</li> </ol>

Course L3091: Special Topics in Steel Design	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner, Nikolay Lalkovski
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2378: Special topics	ourse L2378: Special topics of civil engineering 1CP	
Тур		
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Examination Form	Fachtheoretisch-fachpraktische Arbeit	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Dozenten des SD B	
Language	DE	
Cycle	WiSe/SoSe	
Content	The course occurs only if required. The content is defined at short notice.	
Literature	Die Literatur wird kurzfristig festgelegt.	

Course L2379: Special topics	of civil engineering 2 LP
Тур	
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2380: Special topics	Course L2380: Special topics of civil engineering 3 LP	
Тур		
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Fachtheoretisch-fachpraktische Arbeit	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Dozenten des SD B	
Language	DE	
Cycle	WiSe/SoSe	
Content	The course occurs only if required. The content is defined at short notice.	
Literature	Die Literatur wird kurzfristig festgelegt.	

Course L2789: Structural Design		
Тур	Seminar	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	20 min	
scale		
Lecturer	Dr. Jan Mittelstädt	
Language	DE/EN	
Cycle	SoSe	
Content		
Literature	[1] Structure Systems by Heino Engel, Hantje Cantz, 3rd edition (Feb 2007), ISBN-10: 3775718761	
	Form and Force, Designing Efficient, Expressive Structures by Allan, E., Zalewski, W. et al, John Wiley and	
	Sons; 1st edition (Sept 2009), ISBN-10: 047017465X	
	[2] Peter Rice: An Engineer Imagines, ISBN-10 : 1849944237	
	[3] Konrad Wachsmann and the Grapevine Structure by C. Sumi et al., Park Books (Oct 2018), ISBN-10:	
	9783038601104	
	[4] Manual of Multi-Story Timber Construction by Hermann Kaufmann, Stefan Krotsch, Stefan Winter, DETAIL,	
	(June 2018), ISBN-10: 3955533948	
	[5] The Art of Structural Design: A Swiss Legacy by B. Billington, Princeton University Art Museum; First Edition	
	edition (Mar 2003), ISBN-10: 0300097867	
	[6] Structured Lineages: Learning from Japanese Structural Design by G. Nordenson et al, The Museum of	
	Modern Art (Jul 2019), ISBN-10: 1633450562	
	[7] The Structure: Works of Mahendra Raj by V. Mehta, R. Mehndiretta, A. Huber, Park Books (Oct 2015),	
	ISBN-10: 3038600253	

Courses	
Title Adaptation to climate change in hy	Typ     Hrs/wk     CP       rdraulic engineering (L2291)     Project-/problem-based Learning     4     6
Module Responsible	Prof. Peter Fröhle
Admission Requirements	
Recommended Previous Knowledge	Hydrology Hydraulic Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence Knowledge Skills	<ul> <li>Climate protection and climate adaptation</li> <li>Insights into climate change and its regional characteristics - fundamentals, climate modelling / climate models</li> <li>Impacts of climate change on the components of the regional hydrological cycle</li> <li>Fundamentals of analysis of climate data</li> <li>Consequences of the impact of the climate change</li> <li>Measures for climate adaptation</li> <li>Assessment, prioritization and communication of adaptation measures</li> <li>Fundamentals of the analysis of hydrometeorological and hydrological data</li> </ul>
<b>Personal Competence</b> Social Competence Autonomy	<ul> <li>Working in heterogenous groups</li> <li>Working with different scientific / non-scientific disciplines</li> <li>Self reflection</li> </ul>
	Autonomous work on complex tasks
_	
	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	
Examination Examination duration and scale	Written elaboration Preparation of a written report and a presentation of a complex task.
•	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation Water: Elective Compulsory

Course L2291: Adaptation to	o climate change in hydraulic engineering		
Тур	Project-/problem-based Learning		
Hrs/wk	4		
СР			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Lecturer	Prof. Peter Fröhle		
Language	DE		
Cycle	WiSe		
Content	<ul> <li>Climate protection and climate adaptation</li> <li>Findings on climate change and its regional characteristics: fundamentals of climate change, climate modelling / climate models</li> <li>Impacts of climate change on the components of the regional hydrological cycle(climate science view)</li> <li>Fundamentals of the analysis of climate data</li> <li>Concequences of the impacts of climate change (ingenieering science view)</li> <li>Measures for climate change adaptation</li> <li>Assessment, prioritization and communication of measures</li> <li>Fundamentals of analysis of hydrometeorological and hydrological data</li> </ul>		
Literature	<ul> <li>Wird bereitgestellt über die HOOU - eLearning Plattform</li> <li>abhängig von den jeweils schwerpunktmäßig behandelten Fragestellungen wird das Schrifttum (aktuelle Paper) in der Veranstaltung bzw. über StudIP zur Verfügung gestellt.</li> </ul>		

Courses				
Title		Тур	Hrs/wk	СР
Sustainable Nature-based Coastal	Protection in a Changing Climate (SeaPiaC) (L2926)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Hydraulic Engineering</li> <li>Hydromechanics, Hydraulics</li> <li>Fundamentals of Coastal Engineering, Coastal- an</li> </ul>	d Flood Protection		
Educational Objectives				
Professional Competence	After taking part successfully, students have reached the	e following learning results		
Knowledge	<ul> <li>Climate and Climate Change</li> <li>General Impacts of Climate Change on Wind Regi</li> <li>Consequences of Climate Change for Coastal Proc</li> <li>Coastal Protection in Taiwan and Germany</li> <li>Fundamentals of Climate Adaptation</li> <li>Nature-based Solutions (NBS) for Coastal Protection</li> </ul>	esses		
Skills	<ul> <li>Critical thinking: analysis of processes and relatio</li> <li>Creative thinking: development of adaptation stra</li> <li>Practical thinking: inclusion of restrictions, appl methods</li> <li>Consideration of complex tasks</li> </ul>	tegies and adaptation measures	nods, numerica	al models, plannir
Personal Competence Social Competence	<ul> <li>Working in heterogenous groups</li> <li>Working in international groups</li> <li>Working with different scientific / non-scientific distribution</li> <li>Self reflection</li> </ul>	sciplines		
Autonomy	<ul> <li>Sen relection</li> <li>Application oriented use of knowledge and skills</li> <li>Autonomous work on complex tasks</li> </ul>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
	Written elaboration			
	Preparation of a written report on a complex task with	a presentation and subsequent discussion	on. The work o	n the complex ta
	happens in the course of the lecture.			
	Civil Engineering: Specialisation Coastal Engineering: Ele Civil Engineering: Specialisation Geotechnical Engineerin Civil Engineering: Specialisation Structural Engineering: Civil Engineering: Specialisation Water and Traffic: Elect Environmental Engineering: Specialisation Environment	ng: Elective Compulsory Elective Compulsory ve Compulsory and Climate: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cit Water and Environmental Engineering: Specialisation En Water and Environmental Engineering: Specialisation Wa	vironment: Elective Compulsory		

Course L2926: Sustainable N	ature-based Coastal Protection in a Changing Climate (SeaPiaC)
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Peter Fröhle
Language	EN
Cycle	WiSe
Content	<ul> <li>Climate and Climate Change</li> <li>General Impacts of Climate Change on Wind Regime and Water Cycle</li> <li>Consequences of Climate Change for Coastal Processes</li> <li>Coastal Protection in Taiwan and Germany</li> <li>Fundamentals of Climate Adaptation</li> <li>Nature-Based Solutions (NBS) for Coastal Protection</li> </ul>
Literature	<ul> <li>Materials provided on eLearning Platform (HOOU Platform)</li> <li>Depending on the main topics of the course in the respective year, the literature ( recent papers) will be provided in the course-material or via StudIP.</li> </ul>

Courses				
Title		Тур	Hrs/wk	СР
Scientific Working in Computationa	Engineering (L2764)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge in scientific writing. String interest in topics	s related to computing in civil engine	ering.	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence				
Personal Competence	The students will learn to apply concepts and methods of scientific working in computational engineering. In interaction with the course instructors and in collaboration with each other, the students will also learn to understand the complex process of scientific thinking, being able to accurately plan, implement and analyze scientific projects, such as prospective master theses. A project will be conducted throughout the semester, which will contribute to the grade. Since scientific writing is of particular importance in this course, a scientific paper will be developed based, which is a prerequisite for the final examination. The paper will be writter based on the project conducted within this course. Project meetings in small groups, presentations, and critical discussions or scientific publications are further key activities. The students will be capable (i) of solving a scientific problem following a scientific methodology, (ii) of documenting their work effectively in the form of a paper, and (iii) of sharing their work in a presentation. The students will be able to work in a multidisciplinary team and develop communication skills necessary for problem solving.			
Autonomy	The students will be able to extend their knowledge and app	bly it to solve scientific problems by w	vorking indepe	ndently in a proje
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement	None			
Examination	Written elaboration			
Examination duration and	10 pages of work with 15-minute oral presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective	Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: B	Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Electiv	e Compulsory		
	Civil Engineering: Specialisation Structural Engineering: Elec	tive Compulsory		
	Civil Engineering: Specialisation Computational Engineering	Elective Compulsory		
	Computer Science: Specialisation II: Intelligence Engineering	1: Elective Compulsory		

Course L2764: Scientific Wor	ourse L2764: Scientific Working in Computational Engineering		
Тур	Project-/problem-based Learning		
Hrs/wk	4		
СР	6		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Lecturer	Prof. Kay Smarsly		
Language	EN		
Cycle	WiSe/SoSe		
Content	In the course, a scientific problem of practical relevance will first be defined, taking into account the interests of the students participating in the course. The scientific problem will then systematically be solved within the framework of a comprehensive project. The principles of scientific working will be taught based on the scientific problem defined previously. As an integral part of scientific working, fundamentals of scientific writing will be presented and applied to a scientific paper to be written during the course. Topics related to scientific writing include structuring in scientific writing (structuring the abstract, the introduction, the main part, the summary and conclusions, and the acknowledgments and references) and recommendations on effective scientific writing (principles of composition, use of English in scientific writing, useful tips, creating figures, writing in mathematics, referencing, and formal email correspondence). A final paper and a final presentation will be assembled by the students.		
Literature	Smarsly, K. & Dragos, K., 2019. Scientific Writing in Engineering. Tredition, Hamburg, Germany.		

Module M1844: Mode	rn discretization methods in stru	ictural mechanics		
Courses				
Title		Тур	Hrs/wk	СР
Modern discretization methods in s	tructural mechanics (L3043)	Lecture	2	3
Modern discretization methods in structural mechanics (L3044) Recitation Section (small) 2 3			3	
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	<ul><li>Finite Element Methods</li><li>Flächentragwerke</li></ul>			
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, stur mechanics.	dents can express the basic aspects of moder	n discretization r	nethods in structu
Skills	After successful completion of this module, the students will be able to use and further improve modern discretization methods for problems in structural mechanics.			
Personal Competence				
Social Competence	Students can			
	<ul> <li>participate in subject-specific and interdi</li> </ul>	scinlinary discussions		
	<ul> <li>defend their own work results in front of</li> </ul>			
	<ul> <li>promote the scientific development of co</li> </ul>			
	• Furthermore, they can give and accept p	rofessional constructive criticism		
Autonomy	Students are able to gain knowledge of the sub	iect area from given and other sources and a	only it to new pro	blems Furthermor
hatohomy	they are able to structure the solution process f			bienis. Furthermol
Workload in Hours	Independent Study Time 124, Study Time in Leo	ture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engine	ering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical E	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Engi	neering: Elective Compulsory		
	Civil Engineering: Specialisation Computational			
	Theoretical Mechanical Engineering: Specialisat	ion Simulation Technology: Elective Compulso	ry	

Course L3043: Modern discre	etization methods in structural mechanics
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	EN
Cycle	WiSe
Content	<ul> <li>The course covers variational formulations, various locking phenomena and alternative formulations for finite elements and modern discretization schemes in the context of structural mechanics, like isogeometric analysis.</li> <li>variational formulation of finite elements, mixed variational principles</li> <li>geometrical and material locking effects in structural and solid mechanics</li> <li>hybrid-mixed and enhanced assumed strain finite element formulations, reduced integration and stabilization, DSG method, u-p formulations</li> <li>patch test, stability, convergence</li> <li>linear and non-linear analyses</li> <li>introduction to isogeometric analysis</li> <li>isogeometric beam, plate and shell formulations</li> <li>locking effects and their avoidance in modern, smooth discretization schemes, like isogeometric analysis</li> </ul>
Literature	<ul> <li>lecture notes and selected scientific papers</li> <li>O.C. Zienkiewicz, R.L. Taylor, and J.Z. Zhu: Finite Element Method: Its Basis and Fundamentals. Elsevier, 2013.</li> <li>J. Austin Cottrell, Thomas J. R Hughes, Yuri Bazilevs: Isogeometric Analysis: Toward Integration of CAD and FEA. Wiley, 2009.</li> </ul>

Course L3044: Modern discre	urse L3044: Modern discretization methods in structural mechanics		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Typ Lecture g learning results vith case studies),	Hrs/wk 2 2	<b>CP</b> 3 3
Lecture Lecture g learning results vith case studies),	2	3
g learning results		
g learning results vith case studies),	2	3
vith case studies),		
ng,		
ng,		
ne construction proces	SS,	
entitled to?		
n in a legally balancer	d way Students learn h	ow to use legal :
didenoity on the const	and a carget	
utions.		
and organize their time	e and learning manager	ment based on th
	entitled to? on in a legally balance struction) on the const lutions.	the construction process, entitled to? on in a legally balanced way. Students learn h struction) on the construction site in a target lutions. and organize their time and learning manager mpulsory re Compulsory Compulsory ulsory

Course L3182: Construction	urse L3182: Construction law BGB and VOB - law in (excavation) practice		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Günther Schalk		
Language	DE		
Cycle	WiSe		
Content			
Literature	Literatur: - Folienskript (in der Vorlesung erhältlich) - Fuchs/Maurer/Schalk: Handbuch Tiefbaurecht		

Course L3181: Construction	urse L3181: Construction disputes from construction (excavation) practice		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Ingo Junker		
Language	DE		
Cycle	WiSe		
Content			
Literature			

Courses					
Title		Тур		Hrs/wk	СР
Coastal- and Flood Protection (L080	8)	Lecture		<b>пі 5/ w к</b> 2	3
Coastal- and Flood Protection (L141	- /		m-based Learning	1	1
Maintenance and Defence of Flood	Protection Structures (L1411)	Lecture	5	2	2
Module Responsible	Prof. Peter Fröhle				
Admission Requirements	None				
<b>Recommended Previous</b>	Coastal Engineering I				
Knowledge					
Educational Objectives	After taking part successfully, students have	e reached the following learning res	ults		
Professional Competence					
Knowledge	The students have the capability to define	and explain in detail the importan	t aspects of erosic	on protection	and flood protecti
	and are able to apply the aspects to practical coastal protection problems. They are able to design and dimension importan				
	coastal protection measures from the function	onal and from the constructional po	pint of view.		
Skills	Skills The students are able to select design approaches for the functional and constructional design of erosion and			and flood protect	
Skiis	measures and apply these approaches to practical design tasks.				
		5			
Personal Competence					
Social Competence	The students are able to deploy their gain	• • • •			-
	coastal and flood protection structures. Add				isciplines.
-	The students will be able to independently e	•,	to new problems.		
	Independent Study Time 110, Study Time in	Lecture 70			
Credit points					
Course achievement	None				
Examination	Written exam				
Examination duration and	The duration of the examination is 130 m	in. The examination includes tasks	s with respect to	the general u	inderstanding of t
scale	lecture contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Coastal Eng	jineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnic	al Engineering: Elective Compulsor	ý		
	Civil Engineering: Specialisation Structural E				
	Environmental Engineering: Specialisation E	nvironment and Climate: Elective C	Compulsory		
	Environmental Engineering: Specialisation V Water and Environmental Engineering: Specialisation			lsory	

Course L0808: Coastal- and F	lood Protection
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	EN
Cycle	WiSe
Content	Protection of sandy coasts
	<ul> <li>Sediment transport</li> <li>Morphology</li> <li>Technical solution for the protection of sandy coasts <ul> <li>Construction in direction of the coast</li> <li>Constructions perpendicular to the coast</li> <li>Other Concepst</li> </ul> </li> <li>Calculation approaches and numerical models</li> <li>Flood Protection <ul> <li>Classification of constructions / measures</li> <li>Dikes</li> <li>Dunes</li> <li>Foreland - constructions</li> <li>Flood-Protection Walls</li> <li>Drainage of the hinterland</li> </ul> </li> </ul>
Literature	Vorlesungsumdruck
1	Coastal Engineering Manual CEM

Course L1415: Coastal- and I	urse L1415: Coastal- and Flood Protection		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1411: Maintenance	ourse L1411: Maintenance and Defence of Flood Protection Structures	
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Olaf Müller	
Language	EN	
Cycle	WiSe	
Content	<ul> <li>Dike protection</li> <li>Maintennance of flood protection measures</li> </ul>	
Literature	Vorlesungsumdruck	

Courses				
			Line foods	<b>CD</b>
<b>Title</b> Waste and Environmental Chemist	m (10228)	<b>Typ</b> Practical Course	Hrs/wk	<b>CP</b> 2
Biological Waste Treatment (L0318		Project-/problem-based		4
Module Responsible				
Admission Requirements				
Recommended Previous				
Knowledge	5			
Educational Objectives		have reached the following learning results		
Professional Competence				
		ncerning the planning of biological waste treat	ment plants. Students a	are able to explain
nnomeage		bic waste treatment plants in detail, describe		
		ints and explain different methods for waste a		g
Skills	The students are able to discuss the con	npilation of design and layout of plants. They o	can critically evaluate to	echniques and qua
		n recherché and evaluate literature and date		
	and plan additional tests. They are capa	ble of reflecting and evaluating findings in the	group.	
Personal Competence				
Social Competence	Students can participate in subject-spec	cific and interdisciplinary discussions, develop	cooperated solutions ;	and defend their
	work results in front of others and promote the scientific development in front of colleagues. Furthermore, they can give a			
	accept professional constructive criticisr	n.		
Autonomy	Students can independently tap knowle	dge from literature, business or test reports a	and transform it to the	course projects. T
	are capable, in consultation with supervi	isors as well as in the interim presentation, to	assess their learning le	vel and define fur
	steps on this basis. Furthermore, they o	can define targets for new application-or rese	arch-oriented duties in	accordance with
	potential social, economic and cultural in	npact.		
Workload in Hours	Independent Study Time 110, Study Tim	e in Lecture 70		
Credit points				
Course achievement		Description		
	Yes None Subject theore practical work	tical and		
F				
Examination				
Examination duration and scale		utes in groups)		
		Engineering, Elective Compulsory		
Assignment for the Following Curricula		5 5 1 5		
Following curricula	Civil Engineering: Specialisation Geotect			
	Civil Engineering: Specialisation Stratta Civil Engineering: Specialisation Water a			
		<ul> <li>General Bioprocess Engineering: Elective Co</li> </ul>	ompulsorv	
		pecialisation General Process Engineering: Elective ele		
		pecialisation Bioprocess Engineering: Elective		
		pecialisation Chemical Process Engineering: El		
	Environmental Engineering: Core Qualifi		· -	
	1			
	International Management and Engineer	ing: Specialisation II. Renewable Energy: Elect	live Compulsory	
		ing: Specialisation II. Renewable Energy: Elect ronmental Process Engineering: Elective Comp		
	Process Engineering: Specialisation Envi			

Course L0328: Waste and En	vironmental Chemistry
	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	The participants are divided into groups. Each group prepares a transcript on the experiment performed, which is then used as basis for discussing the results and to evaluate the performance of the group and the individual student. In some experiments the test procedure and the results are presented in seminar form, accompanied by discussion and results evaluation. Experiments ar e.g. Screening and particle size determination Fos/Tac AAS Chalorific value
Literature	Scripte

Course L0318: Biological Wa	ste Treatment	
Тур	roject-/problem-based Learning	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Kerstin Kuchta	
Language	EN	
Cycle	WiSe	
Content	<ol> <li>Introduction</li> <li>biological basics</li> <li>determination process specific material characterization</li> <li>aerobic degradation ( Composting, stabilization)</li> <li>anaerobic degradation (Biogas production, fermentation)</li> <li>Technical layout and process design</li> <li>Flue gas treatment</li> <li>Plant design practical phase</li> </ol>	
Literature		

Courses				
Title		Тур	Hrs/wk	СР
Finite element modeling of structur		Lecture	2	3
Finite element modeling of structur	es (L3047)	Recitation Section (small)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
<b>Recommended Previous</b>	Finite Element Methods			
Knowledge	Thin-walled structures			
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module,	students can express the basic aspects of modelli	ng of structures v	with finite elements
Skills	After successful completion of this module	e, the students will be able to model structures	with finite elem	ents and to analy
SKIIIS	structures using appropriate computational		with finite cieffi	
	structures using appropriate computational	incentous.		
Personal Competence				
Social Competence	Students can			
	<ul> <li>participate in subject-specific and interest</li> </ul>	erdisciplinary discussions		
	<ul> <li>defend their own work results in front</li> </ul>			
	<ul> <li>promote the scientific development o</li> </ul>			
	• Furthermore, they can give and acce	•		
Autonomy		subject area from given and other sources and ap		
	they are able to structure the solution proce	ss for problems in the area of finite element mode	elling of structure	es.
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points				
Course achievement	None			
Examination	Written elaboration			
Examination duration and	written elaboration of a project work (10-15	pages)		
scale				
Assignment for the	Civil Engineering: Specialisation Computatio	nal Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal Eng	ineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotechnic	al Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural E	ngineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Special	isation Simulation Technology: Elective Compulso	rv	

ourse L3046: Finite element modeling of structures		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	EN	
Cycle	WiSe	
	<ul> <li>Basic phenomena and aspects of the finite element modelling of structures are discussed. Besides theoretical decription of the phenomena and methods, a strong focus is on the practical use a commercial finite element software within computer-based exercises. The covered topics are: <ul> <li>finite element modeling of trusses/beams/frames, plates subject to in-plane/out-of-plane loading and shells</li> <li>convergence properties of displacements and stresses</li> <li>singularities</li> <li>locking effects</li> <li>critical assessment, interpretation and check of results</li> <li>mixed-dimensional coupling of finite elements</li> <li>geometrically linear and non-linear, and material linear and non-linear analyses</li> <li>stability: bifurcation and snap-through problems</li> <li>dynamic problems, modal analyses</li> </ul> </li> </ul>	
Literature	Vorlesungsmanuskript, Vorlesungsfolien	

Course L3047: Finite elemen	Irse L3047: Finite element modeling of structures		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

			-	
Courses				
Title		Тур	Hrs/wk	СР
Modeling of Subsurface Processes		Recitation Section (sm		3
Subsurface Solute Transport (L272)		Lecture	2	2
Subsurface Solute Transport (L272)		Recitation Section (larg	ge) 1	1
Module Responsible				
Admission Requirements				
	Basic Mathematics, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	• •	dents will understand the mechanisms cor the equations that govern the fate and tra	•	
			isport of solutes in por	ous meula. Analytic
	numerical and experimental tools and techniques will be used in this module.			
Skills	//s In addition to the physical insights, the students will be exposed to analytical, experimental and numerical tools and techr			ools and techniques
	this module. This provides them with an e	xcellent opportunity to improve their skills o	n multiple fronts which	ו will be useful in th
	future career.			
Personal Competence				
Social Competence	Teamwork & problem solving			
Autonomy	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability ar			
	willingness to work independently and res	oonsibly.		
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Report			
scale				
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechni	cal Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Er	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and	l Traffic: Elective Compulsory		
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory		
	Environmental Engineering: Core Qualifica	tion: Compulsory		
	Process Engineering: Specialisation Enviro	nmental Process Engineering: Elective Comp	oulsory	
	Process Engineering: Specialisation Proces	s Engineering: Elective Compulsory		
	Water and Environmental Engineering: Spe	• • • •		

Course L2731: Modeling of S	Course L2731: Modeling of Subsurface Processes		
Тур	Recitation Section (small)		
Hrs/wk	3		
СР	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Dr. Milad Aminzadeh		
Language	EN		
Cycle	WiSe		
Content	Basic usage and background of chosen computer software to calculate flow and transport in the saturated and unsaturated zone and to analyze field data like pumping test data		
Literature			

Course L2728: Subsurface So	ourse L2728: Subsurface Solute Transport		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Nima Shokri		
Language	EN		
Cycle	WiSe		
Content	Basic physical properties of soil: Definition and quantification; Liquid flow in soils (Darcy's law); Solute transport in soils; Practical analysis to measure dispersion coefficient in soil under different boundary conditions; Advanced topics (e.g. Application of Artificial Intelligence to predict soil salinization)		
Literature	- Environmental Soil Physics, by Daniel Hillel - Soil Physics, Sixth Edition, by William A. Jury and Robert Horton		

Course L2729: Subsurface So	urse L2729: Subsurface Solute Transport		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Hannes Nevermann		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

## **Specialization Structural Engineering**

## Module M0713: Concrete Structures

Courses						
Title			Тур		Hrs/wk	СР
Concrete Structures (L0579)			Semir	nar	1	1
Structural Concrete Members (L057	77)		Lectu	re	2	3
Structural Concrete Members (L05	78)		Recita	ation Section (large)	2	2
Module Responsible	NN					
Admission Requirements	None					
<b>Recommended Previous</b>	Basics of structural	analysis, conception ar	nd dimensioning of structura	l concrete		
Knowledge	Modules: Reinforcer	d Concrete Structures L	+II, Structural Analysis I+II, I	Mechanics I+II		
	Modules. Reinforced					
Educational Objectives	After taking part su	ccessfully, students hav	ve reached the following lea	rning results		
Professional Competence						
Knowledge	The students broad	en their skills in structu	aral engineering, especially i	n the field of buildings	(houses, roofs, h	alls). They dispose o
	the knowledge for t	he conception and desi	ign of concrete buildings and	l structural members t	hat are often use	d.
	The students are al					
SKIIIS			s of the conception and dim	•		
	They are capable to draft concrete buildings and to design them for general action effects and to plan their detailing ar execution. Moreover, they can make design and construction sketches and draw up technical descriptions.					
	execution. Moreove	r, they can make desig	IT and construction sketches	and draw up technica	r descriptions.	
Personal Competence						
Social Competence	The students are able to obtain results of high quality in teamwork.					
						<b>6</b> • • •
Autonomy	The students are ac	ble to carry out complex	conception and dimensioni	ng tasks of structures	under the guidan	ce of tutors.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70					
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	No None	Presentation	Es werden 2 Refera	te ausgegeben		
Examination	Written exam					
Examination duration and	120 minutes					
scale						
Assignment for the	Civil Engineering: S	pecialisation Structural	Engineering: Compulsory			
Following Curricula	Civil Engineering: S	pecialisation Geotechni	ical Engineering: Elective Co	mpulsory		
-	Civil Engineering: S	pecialisation Coastal Er	ngineering: Elective Compuls	ory		
			Traffic: Elective Compulsor	•		
			ional Engineering: Elective C			
	5		5 5			

Course L0579: Concrete Stru	Course L0579: Concrete Structures		
Тур	Seminar		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	NN		
Language	DE		
Cycle	WiSe		
Content	With help of a project teamwork the subjects of the course "Concrete Structures" is practiced, discussed and presented.		
Literature	- Projektbezogene Unterlagen werden abgegeben.		

Course L0578: Structural Concrete Members		
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	NN	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Numerical Methods in Geotechnics	(L0375)	Lecture	3	3
Advanced Foundation Engineering	L0497)	Lecture	2	2
Advanced Foundation Engineering	L0498)	Recitation Section (large)	1	1
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
<b>Recommended Previous</b>	Geotechnics I and II, Mathematics I-III			
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
<b>Professional Competence</b>				
-	After successfully completing the module, stud	lents will be able to		
-				
		eotechnical monitoring of civil engineering mea	asures,	
	<ul> <li>reproduce exploration and investigation</li> </ul>			
		tory tests for subsoil investigation and evaluate		
		tress and deformation states and the physical	significance of in	variants of the stre
	and distortion tensor,			
		chanics tests used to determine the stress-stra	in benavior of so	ΙΙ,
	describe continuum models and the res	• • •		
		ems from the field of geotechnical engineering	in such a way tha	it they can be solv
	unambiguously.			
Skills	Students will be able to			
	<ul> <li>dimension vertical drains for soil improvement of soft soils,</li> <li>calculate depth compaction using various appropriate methods,</li> <li>apply principles of horizontal bearing capacity of piles,</li> <li>verify the internal and external stability of fluid-supported diaphragm walls,</li> <li>evaluate the boundary conditions for the design of a deep excavation and design the individual components</li> </ul>			components of t
	<ul><li> computationally implement numerical a</li><li> select and apply the types of analyses of</li></ul>	r the description and classification of soils acco lgorithms to solve boundary value problems, depending on the degree of saturation, the imp rs for different possibilities and limitations of n	act, and the mate	erial behavior
Personal Competence				
	Students can work in groups and support each	other in finding solutions.		
		-		
Autonomy		is and weaknesses and, based on this, organize	their time and le	earning manageme
	and think in terms of processes.			
Workload in Hours	Independent Study Time 96, Study Time in Leo	cture 84		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Eng			
Following Curricula	Civil Engineering: Specialisation Geotechnical			
	Civil Engineering: Specialisation Coastal Engin	• • •		
	Civil Engineering: Specialisation Water and Tra	attic: Flective Compulsory		
	Civil Engineering: Specialisation Computationa			

Course L0375: Numerical Me	thods in Geotechnics		
Тур	ecture		
Hrs/wk	3		
СР	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Dr. Hans Mathäus Stanford		
Language	DE		
Cycle	WiSe		
Content	Topics:		
	<ul> <li>Introduction to numerical soil mechanics</li> <li>Introduction to numerical mathematics</li> <li>Finite Element Method (analysis procedures, algorithms)</li> <li>Finite Element Method (application in geotechnical engineering)</li> </ul>		
Literature	<ul> <li>Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden. Springer</li> <li>Wriggers P. (2008): Nonlinear Finite Element Methods. Springer</li> <li>Deutsche Gesellschaft für Geotechnik e.V. (Hrsg., 2014): Empfehlungen des Arbeitskreises "Numerik in der Geotechnik". Ernst &amp; Sohn</li> </ul>		

Course L0497: Advanced Fou	Course L0497: Advanced Foundation Engineering		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Jürgen Grabe		
Language	DE		
Cycle	WiSe		
Content	<ul> <li>Vertical drains</li> <li>Piles</li> <li>Ground improvement (Deep Compaction, Soil mixing)</li> <li>Vibration driving</li> <li>Jet grouting</li> <li>Slurry wall</li> <li>Deep excavation</li> </ul>		
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>EAB (1988): Empfehlungen des Arbeitskreises Baugruben</li> <li>Grundbau-Taschenbuch, Teil 1-3, (1997), Ernst &amp; Sohn Verlag</li> </ul>		

Course L0498: Advanced Fou	ourse L0498: Advanced Foundation Engineering		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Jürgen Grabe		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Modulo M0063: Stool	and Composite Structures			
Module M0905: Steel	and composite structures			
Courses				
Title		Тур	Hrs/wk	СР
Steel and Composite Structures (L1	204)	Lecture	2	2
Steel and Composite Structures (L1	205)	Recitation Section (large)	2	2
Steel Bridges (L1097)		Lecture	2	2
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of steel construction (i.e. Steel Structures I and	d II, BUBC)		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
<b>Professional Competence</b>				
Knowledge	After successful completition, students can			
	<ul> <li>describe the phenomenon of local buckling</li> </ul>			
	explain warping torsion			
	<ul> <li>illustrate the behaviour of composite structure</li> </ul>	S		
	<ul> <li>specify the principles in design of composite si</li> </ul>			
	<ul> <li>sketch the contructions of steel and composite</li> </ul>			
Skills	After successful participation students are able to			
	<ul> <li>check stiffened and unstiffened plated structure</li> </ul>	res		
	<ul> <li>recognize and verify warping tosion in strucure</li> </ul>	25		
	<ul> <li>design composite structures</li> </ul>			
	design bridges and o perform the detailing			
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	4		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering	ng: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	ering: Elective Compulsory		
-	Civil Engineering: Specialisation Coastal Engineering:			
	Civil Engineering: Specialisation Water and Traffic: El			
	Civil Engineering: Specialisation Computational Engin			
	International Management and Engineering: Specialis	•	ulcon	

Course L1204: Steel and Composite Structures		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Marcus Rutner	
Language	DE	
Cycle	WiSe	
Content	<ul> <li>Local-buckling of plated structures</li> <li>Warping torsion</li> <li>Composite-girders, -columns, -slabs, -bridges</li> <li>Principles in composite constructions</li> <li>Bridge-design and -construction</li> </ul>	
Literature	Petersen, C.: Stahlbau, 4.Auflage 2013, Springer-Vieweg Verlag Minnert, J. Wagenknecht, G.: Verbundbau-Praxis - Berechnung und Konstruktion nach Eurocode 4, 2.Auflage 2013, Bauwerk Beuth Verlag	

Course L1205: Steel and Con	ourse L1205: Steel and Composite Structures				
Тур	Recitation Section (large)				
Hrs/wk	2				
СР	2				
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
Lecturer	Prof. Marcus Rutner				
Language	DE				
Cycle	WiSe				
Content	See interlocking course				
Literature	See interlocking course				

Course L1097: Steel Bridges				
Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Yves Freundt			
Language				
Cycle				
Content	Lecture Contents ,Steel Bridge Construction' DrIng. Jörg Ahlgrimm			
	Drnig. Jorg Angrinnin			
	- From tendering and contracting to completion - the development of a steel bridge			
	- Contents of a bridge static - structural details, examples of analysis in detail:			
	-> effective width in regard to the longitudinal stiffeners			
	-> Bearing point, bearing stiffener			
	-> Crossbeam breakthrough, crossbeam reinforcement			
	-> Analysis of the Rib-to-Floorbeam (RF) connection (web-tooth of the floorbeam between trapezoidal shaped Ribs)			
	Steel grades, -designation, testing methods and approval certificates			
	Nondestructive weld inspecting			
	- Corrosion protection			
	- Bridge bearing - types, format, function, dimensioning, installation			
	- Expansion Joints			
	- Oscillation of bridge hangers and cables - oscillation damper			
	- Opening bridges- Detailed reviews to different assembling procedures and - implements			
	- Selective damage events			
	Requirements: Basic knowledge in the calculation, dimensioning, and construction of structural elements and joints of constructional steelwork			
Literature				
	Herbert Schmidt, Ulrich Schulte, Rainer Zwätz, Lothar Bär:     Ausführung von Stahlbauten			
	Petersen, Christian: Stahlbau, Abschnitt Brückenbau			
	<ul> <li>Ahlgrimm, J., Lohrer, I.: Erneuerung der Eisenbahnüberführung in Fulda-Horas über die Fulda, Stahlbau 74 (2005), Heft 2, S.</li> <li>114</li> </ul>			

Courses	
Fitle Construction Robotics (L2867)	Typ     Hrs/wk     CP       Project-/problem-based Learning     6     6
Module Responsible	Prof. Kay Smarsly
Admission Requirements	None
<b>Recommended Previous</b>	Basics of project-oriented programming
Knowledge	
	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Basics of robotics
	Applications in civil engineering
	Kinematics
Skills	Use of specific hardware
	Development of software routines
	Python programming language
	Image processing
	Basics of localization (LIDAR, SLAM)
Personal Competence	
Social Competence	Teamwork
	Communication skills
Autonomy	Independent work
	Independent decisions
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	
Examination duration and	
scale	
-	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Coasta Engineering: Elective Compulsory
	Civil Engineering: Specialisation Computational Engineering: Elective Compulsory
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory
	Mechatronics: Core Qualification: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory

Тур	Project-/problem-based Learning			
Hrs/wk	6			
СР				
Workload in Hours	dependent Study Time 96, Study Time in Lecture 84			
Lecturer	of. Kay Smarsly, Jan Stührenberg			
Language	EN			
Cycle	WiSe			
Content	<ol> <li>Introduction: Robotics in civil engineering</li> <li>Presentation of potential topics</li> <li>Programming of algorithms in Python</li> <li>Application of software systems: LINUX distribution, ROS, CloudCompare,</li> <li>Application of hardware systems: Petoi Bittle Dog, Raspberry Pi, Arduino, sensing</li> <li>Topics considered for robotics using the Petoi Bittle Dog:         <ol> <li>Movement</li> <li>Use of sensors (camera, infrared,)</li> <li>Data structures/data acquisition</li> <li>Programming</li> </ol> </li> <li>Topics technically relevant to building inspection:         <ol> <li>Geodetic evaluations</li> <li>Image processing</li> <li>Localization</li> </ol> </li> </ol>			
Literature	Bock/Linner: Construction Robotics			
	Verl et al.: Soft Robotics			
	Pasquale: New Laws of robotics			

Courses				
Title		Тур	Hrs/wk	СР
Digital Twinning in Civil Engineerin	g (L3136)	Lecture	2	2
Digital Twinning in Civil Engineering (L3137)		Seminar	2	4
Module Responsible	Alexander Chmelnizkij			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	20 min presentation and 5 pages handou	t		
scale				
Assignment for the	Civil Engineering: Specialisation Computa	tional Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal E	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structure	al Engineering: Elective Compulsory		

Course L3136: Digital Twinning in Civil Engineering				
Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	dent Study Time 32, Study Time in Lecture 28			
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly			
Language	DE			
Cycle	SoSe			
Content				
Literature				

Course L3137: Digital Twinn	Course L3137: Digital Twinning in Civil Engineering		
Тур	Seminar		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Design of Prestressed Structures and Concreet Bridges (L0603)		Lecture	3	4
Design of Prestressed Structures a	nd Concreet Bridges (L0604)	Recitation Section (large)	2	2
Module Responsible	NN			
Admission Requirements	None			
<b>Recommended Previous</b>	Detailed knowledge on the design of concr	rete structures.		
Knowledge	Madulaa, Dainfanaad Cananata Churchuraa I	U. Chrysteinel Analysia I. U. Mashanina I. U. Conser	-t- Church uno	
	Modules: Reinforced Concrete Structures I	+II, Structural Analysis I+II, Mechanics I+II, Concre	ete Structures	
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	The students know the main bridge types, their applications and the various loads. They can explain the basic design method			
	They can explain the design of a prestressed bridge.			
CI-ill-				
SKIIIS	The students are able to design reinforced or prestressed concrete bridges.			
Personal Competence				
Social Competence	The students can design in teamwork a rea	al concrete bridge.		
4	The students are able to desire a grant			
Αυτοποτηγ	The students are able to design a prestres	sed concrete bridge and discuss the problems and	i results with othe	r students.
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 minutes			
scale				
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Computational Engineering: Elective Compulsory			
	International Management and Engineering			

Course L0603: Design of Pre	stressed Structures and Concreet Bridges
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	NN
Language	DE
Cycle	SoSe
Content	prestressed structures
	<ul> <li>basis of prestressed structures, field of application</li> <li>differences between reinforced and prestressed concrete structures</li> <li>history of prestressing</li> <li>construction materials: concrete, tendons, ducts, anchorage systems</li> <li>construction: prestressing methods</li> <li>prestressing forces and member forces (friction, elongation)</li> <li>tendon layout</li> <li>time dependant prestressing losses</li> <li>design of prestressed structures</li> <li>design of anchorage region</li> <li>non-bonded prestressing</li> <li>prestressed flat slabs</li> </ul>
	Concrete bridges <ul> <li>history of bridges</li> <li>design of bridges</li> <li>loads on bridges</li> <li>loads on bridges</li> <li>member forces for slab, T-beam, hollow box, frame and arch bridges</li> <li>precast bridges - precast segmental bridges</li> <li>bearings</li> <li>abutments, columns</li> <li>construction methods</li> <li>damages - checking of bridges</li> </ul>
Literature	<ul> <li>Vorlesungsumdruckim STUDiP</li> <li>Rombach, G. (2003): Spannbetonbau. Ernst &amp; Sohn, Berlin</li> <li>Wicke, M. (2002): Anwendung des Spannbetons. Betonkalender 2002, Teil II, S. 113-180, Verlag Ernst &amp; Sohn, Berlin</li> <li>Leonhardt, F. (1980): Vorlesungen über Massivbau. Teil 5: Spannbeton. Berlin</li> <li>Mehlhorn, G. (2007): Handbuch Brücken, Springer Verlag</li> <li>Schäfer, H.; Kaufeld, K. (1997): Massivbrücken. Betonkalender Teil II, S. 443ff, Ernst &amp; Sohn, Berlin</li> <li>Menn, Ch. (1986): Stahlbetonbrücken. Springer Verlag, Wien</li> </ul>

Course L0604: Design of Pre	ourse L0604: Design of Prestressed Structures and Concreet Bridges			
Тур	Recitation Section (large)			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	NN			
Language	DE			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

	lechanics and -Dynamics				
Courses					
Title		Тур	Hrs/wk	СР	
Soil Mechanics - Selected Topics (L0374)		Lecture	2	2	
Soil Dynamics (L0452)		Lecture	2	2	
Experimental Researches in Geote	hnics (L0706)	Practical Course	2	2	
Module Responsible	Prof. Jürgen Grabe				
Admission Requirements	None				
<b>Recommended Previous</b>	Modules: Mathematics I-III, Mechanics I-II, Ge	otechnics I			
Knowledge	Courses: Soil laboratory course, (Applied stru	ctural dynamics)			
Educational Objectives	After taking part successfully, students have	reached the following learning results			
Professional Competence					
Knowledge	Students will be able to,				
	<ul> <li>describe wave propagation in the ground under dynamic excitation and define the relevant parameters,</li> <li>to measure vibrations and to interpret the data obtained with regard to their effect on people and structures,</li> <li>justify when elastodynamic methods are sufficient and when plastodynamic effects must be taken into account,</li> <li>to reproduce the collapse theorems of plasticity theory,</li> <li>describe the viscous behavior of cohesive soils and computationally account for creep deformation and rate-dependent strengths</li> <li>as well as to determine the effect of partial saturation on the seepage flow and the shear strength.</li> </ul>			tures, account,	
Skills	/s After the successful completion of the module the students should be able to:				
	<ul> <li>to derive and apply the basic equation</li> </ul>	of a simple mass oscillator			
	<ul> <li>to derive and apply the basic equation of a simple mass oscillator,</li> <li>to understand the wave propagation in the soil under dynamic excitation and to detect the relevant paramete</li> </ul>				
	<ul> <li>to know the essential laboratory and field tests to determine soil dynamic characteristics and to evaluate them,</li> <li>to design machine foundations to dynamic load,</li> </ul>				
	<ul> <li>to measure shocks to perform vibratio</li> </ul>				
	<ul> <li>to evaluate shocks in terms of their effective</li> </ul>				
	<ul> <li>to evaluate possibilities of isolation,</li> </ul>				
	<ul> <li>to understand mechanisms that cause</li> </ul>	earthquakes and evaluate earthquakes in	terms of their magnitu	ide and intensity,	
	<ul> <li>to know methods to determine axial p</li> </ul>	ile capacity, integrity, and the dynamic be	dding modulus,		
	<ul> <li>to know the mechanisms that lead to mathematically,</li> </ul>	a deformation accumulation due to cyclic	loading and to estimat	e these deformatio	
	<ul> <li>to distinguish the area of application of</li> </ul>	f the method of elastodynamics and plasto	odynamics,		
	<ul> <li>to detect the undrained shear strength</li> </ul>	n as a function of a number of state variab	les,		
	calculations,	nesive soils and to consider the effects of	creep and rate-depend	ent shear strength	
	<ul> <li>to consider the impact of the partly sa</li> </ul>	turated of a seepage and shear strength.			
Personal Competence					
Social Competence	Students will be able to work in teams to ac	hieve results on measurement and exper	rimental principles and	present their resu	
	together at the end of the semester.				
Autonomy	Students are able to assess their own strengt	hs and weaknesses and organize their tim	e and learning manage	ement based on thi	
Workload in Hours	Independent Study Time 96, Study Time in L	ecture 84			
Credit points	6	2			
Course achievement	Compulsory         Bonus         Form           Yes         None         Subject         theoretical	Description and			
Eveninet'	practical work				
Examination	Written exam				
Examination duration and scale	135 min				
Assignment for the	Civil Engineering: Specialisation Structural Er	ngineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnica				
<b>3</b> • • • • •	Civil Engineering: Specialisation Coastal Engi				
	Civil Engineering: Specialisation Computation				

Course L0452: Soil Dynamics		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	ependent Study Time 32, Study Time in Lecture 28	
Lecturer	Anne Hagemann	
Language	DE	
Cycle	SoSe	
Content	• mass-spring-damper systems,	
	• wave propagation in soils,	
	• dynamic soil parameters,	
	Determination of dynamic soil parameters,	
	• machine foundations,	
	• in-situ measurement of ground motion, ground motion prediction, evaluation of ground motion,	
	• ground motion shielding,	
	introduction into earthquake engineering,	
	• dynamic pile tests,	
	• cyclic accumulation,	
	• plastodynamics	
Literature	<ul> <li>Das B.M.: Fundamentals of Soil Dynamics, Elsevier</li> <li>Empfehlungen des Arbeitskreises Baugrunddynamik. Hrsg. Deutsche Gesellschaft für Geotechnik (DGGT)</li> <li>Haupt W.: Bodendynamik. Vieweg und Teubner</li> <li>Meskouris K. und Hinzen KG.: Bauwerke und Erdbeben. Vieweg Verlag</li> <li>Studer J.A., Koller M.G. und Laue J.: Bodendynamik, Springer Verlag</li> </ul>	

Course L0706: Experimental	Researches in Geotechnics
Тур	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Hans Mathäus Stanford, Göta Bürkner
Language	DE
Cycle	SoSe
Content	The students are supposed to:
	<ul> <li>become acquainted with geotechnical model tests, field tests and laboratory tests as well as corresponding measurement techniques. These compromise amongst others inclinometer measurements and geophone measurements as well as high-grade laboratory tests on the stress-strain relationship of soil specimens, e. g. triaxial tests, simple shear tests and resonant column tests.</li> <li>gain insight into current soil mechanical research.</li> <li>plan, coordinate, perform and evaluate soil mechanical tests in a team.</li> <li>discuss, reflect, review and present the obtained results in a group.</li> </ul> An important learning target is the introduction to scientific work for students who plan a scientific career, and for those who will work in practice with the responsibility to order corresponding tests and evaluate the results. The practical laboratory work is based on annualy changing problems, which are however related to the experience and results of the preceding year's course group.
Literature	- Grabe, J. (2004): Bodenmechanik und Grundbau, Band 3 der Veröffentlichungsreihe des Instituts für Geotechnik und Baubetrieb, Technische Universität Hamburg-Harburg.
	- Kolymbas, D. (2007): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. 2., korrigierte und ergänzte Auflage, Springer Verlag.
	<ul> <li>Normen zu geotechnischen Versuchsgeräten und Versuchsverfahren:</li> <li>DIN 18135:2012-04: Baugrund, Untersuchung von Bodenproben -</li> <li>Eindimensionaler Kompressionsversuch, Deutsches Institut für</li> <li>Normung, e. V.</li> </ul>
	- DIN 18137-2:2011-04: Baugrund, Untersuchung von Bodenproben - Bestimmung der Scherfestigkeit - Teil 2: Triaxialversuch, Deutsches Institut für Normung e. V.

Module M0827: Mode	ling in Water Management			
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modfl		Lecture	1	1
Groundwater Modeling using Modfle Modeling of Water Supply Network		Recitation Section (small) Project-/problem-based Learnin	2 q 2	2 3
Module Responsible		Floject-problem-based Leannin	y z	5
Admission Requirements				
Recommended Previous				
Knowledge				
j-	<ul> <li>groundwater hydraulics and transport or</li> </ul>	fsubstances		
	Pipe Systems			
		ures, in particular drinking water systemsand	urban drainag	le systems including
	<ul><li>special structures</li><li>Hydraulics of drinking water supply syst</li></ul>	ems and sewer systems		
	Basic knowledge on water management			
	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge		g of groundwater flow and transport as well as		
		chnical and conceptual weak points within the s	ystems in case	studies. Besides the
	are able to analyse interdependencies of hydra	aulic and toxic phenomena in soil and water.		
Chille	The shudents are able to construct and even			
SKIIIS	kills The students are able to construct and apply scientific groundwater models indipendently. They can work on differe			
	and can compare or assess different solutions for existing problems by application of selected software products. The st able to use different software solutions (e.g. EPANET, EPA-SWMM).			
Personal Competence				
Social Competence	Wird nicht vermittelt.			
Autonomy	Wird nicht vermittelt.			
	Independent Study Time 110, Study Time in Le	ecture /0		
Credit points Course achievement				
	Oral exam 30 min			
scale				
	Civil Engineering: Specialisation Structural Enc	ineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Scructural Engineering: Specialisation Geotechnical			
<b>J</b>	Civil Engineering: Specialisation Coastal Engin			
	Civil Engineering: Specialisation Water and Tra			
	Civil Engineering: Specialisation Computationa			
	Water and Environmental Engineering: Special	isation Environment: Elective Compulsory		
	Water and Environmental Engineering: Special	isation Cities: Elective Compulsory		
	Water and Environmental Engineering: Special	isation Water: Elective Compulsory		

Course L0543: Groundwater	Course L0543: Groundwater Modeling using Modflow		
Тур	Lecture		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Sonja Götz		
Language	DE/EN		
Cycle	SoSe		
Content	Introduction and application of the groundwater model MODFLOW (PMWIN); theoretical backround of the modell, students do work		
	with the model PMWIN for practical case studies.		
Literature	MODFLOW-Handbuch		
	Chiang, Wen Hsien: PMWIN		

Course L0544: Groundwater	urse L0544: Groundwater Modeling using Modflow	
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Sonja Götz	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0875: Modeling of Water Supply Network		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Klaus Johannsen	
Language	DE	
Cycle	SoSe	
Content		
Literature	Mutschmann/Stimmelmayr: Taschenbuch der Wasserversorgung, 16. Auflage. Springer Vieweg - Verlag. Wiesbaden 2014.	

Courses				
Title		Тур	Hrs/wk	СР
Noise Protection (L1109) Urban Infrastructures (L0874)		Lecture Project-/problem-based Learning	2 2	2 4
		Project-/problem-based Learning	Z	4
•	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
Recommended Previous	Knowledge on Urban planning			
Knowledge	Knowledge on measures for climate protection			
	<ul> <li>General knowledge of scientific writing/working</li> </ul>			
	After taking part successfully, students have reached the following	ng learning results		
Professional Competence				
Knowledge	Students can describe urban development corridors as well as co	urrent and future urban environr	mental probler	ns. They are able
	explain the causes of environmental problems (like noise).			
	Students can specify applications for various technical innovatio		bute to the im	provement of urb
	life. They can, for example, derive and discuss measures for effe	ctive noise abatement.		
Skills	Ils Students are able to develop specific solutions for correcting existing or future environment-related problem		problems of urb	
	development. They can define a range of conceptual and technical solutions for environmental problems for different deve paths. To solve specific urban environmental problems they can select technical innovations and integrate them into the			
				hem into the urb
	context.			
Personal Competence				
Social Competence	The students can work together in international groups.			
A 4				
Autonomy	Students are able to organize their work flow to prepare themse		ributions to tr	ie discussions. Tr
	can acquire appropriate knowledge by making enquiries indepen	dently.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Written Report plus oral Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective	Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Electi	ve Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective Co	mpulsory		
	Civil Engineering: Specialisation Water and Traffic: Elective Comp	oulsory		
	Environmental Engineering: Core Qualification: Elective Compuls	ory		
	Joint European Master in Environmental Studies - Cities and Susta	ainability: Core Qualification: Cor	mpulsory	
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure	e and Mobility: Elective Compuls	ory	
	Water and Environmental Engineering: Specialisation Environment	nt: Elective Compulsory		

Course L1109: Noise Protection		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Martin Jäschke	
Language	EN	
Cycle	SoSe	
Content		
Literature	1) Müller & Möser (2013): Handbook of Engineering Acoustics (also available in German)	
	2) WHO (1999): Guidelines for Community Noise	
	3) Environmental Noise Directive 2002/49/EG	
	4) ISO 9613-2 (1996): Acoustics, Attenuation of sound during propagation outdoors, Part 2: General method of calculation	

Course L0874: Urban Infrast	urse L0874: Urban Infrastructures		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Lecturer	Dr. Dorothea Rechtenbach		
Language	EN		
Cycle	SoSe		
Content	Problem Based Learning		
	Main topics are:		
	Central vs. Decentral Wastewater Treatment.		
	Compaction of Cities.		
	Car Free Cities.		
	Multifunctional Places in Cities.		
	The Sustainability of Freight Transport in Cities.		
Literature	Depends on chosen topic.		

Courses				
Title		Тур	Hrs/wk	СР
Harbour Engineering (L0809)		Lecture	2	2
Harbour Engineering (L1414)		Project-/problem-based Learning	1	2
Port Planning and Port Construction	n (L0378)	Lecture	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of coastal engineering			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follo	wing learning results		
Professional Competence				
Knowledge	The students are able to define in details and to choose desi	gn approaches for the functional c	lesign of a po	rt and apply ther
	design tasks. They can design the fundamental elements of a port.			
Chille	The students are able to calest and apply appropriate approach	has for the functional design of no	rta	
SKIIIS	The students are able to select and apply appropriate approac	thes for the functional design of po	rts.	
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in a	pplied problems such as the funct	tional design	of ports. Addition
	they will be able to work in team with engineers of other disci	olines.		
Autonomy	The students will be able to independently extend their knowledge	edge and apply it to new problems		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 150 min. The examination	on includes tasks with respect to	the general u	understanding of
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Electi	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Ele	ctive Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Compuls	sory		
	Civil Engineering: Specialisation Water and Traffic: Elective Co	mpulsory		
	International Management and Engineering: Specialisation II.	Civil Engineering, Elective Compute		

Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	SoSe
Content	<ul> <li>Fundamentals of harbor engineering <ul> <li>Maritime transportation and waterways engineering</li> <li>Ships</li> </ul> </li> <li>Elements of harbors <ul> <li>Harbor approaches and water-side harbor areas</li> <li>Terminal design and handling of cargo</li> <li>Quay-walls and piers</li> <li>Equipment of harbors</li> <li>Sluices and other special constructions</li> </ul> </li> <li>Connection to inland transportation / inland waterway transportation</li> <li>Protection of harbors <ul> <li>Breakwaters and Jetties</li> <li>Wave protection of harbors</li> </ul> </li> <li>Fishery and other small harbors</li> </ul>
Literature	Brinkmann, B.: Seehäfen, Springer 2005

Course L1414: Harbour Engi	urse L1414: Harbour Engineering	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Peter Fröhle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

тур	ecture	
Hrs/wk	2	
СР	2	
Vorkload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Frank Feindt	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>Planning and implementation of major projects</li> <li>Market analysis and traffic relations</li> <li>Planning process and plan</li> <li>Port planning in urban neighborhood</li> <li>Development of the logistics center "Port of Hamburg" in the metropolis</li> <li>Quays and waterfront structure</li> <li>Special planning Law Harbor - securing of a flexible use of the port</li> <li>Dimensioning of quays</li> <li>Flood protection structures</li> <li>Port of Hamburg - Infrastructure and development</li> <li>Preparation of areas</li> <li>Scour formation in front of shore structures</li> </ul>	

Courses				
Title		Түр	Hrs/wk	СР
Hydraulic Models (L0813)		Project-/problem-based Learning	1	1
Modelling of Waves (L0812)		Project-/problem-based Learning	1	1
Modelling of Flow in Rivers and Est	uaries (L0810)	Lecture	3	4
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>	Coastal Hydraulic Engineering I			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic processes	that are related to the modelling	of flows in hy	ydraulic engineerir
	Besides, they can describe the basic aspects of numerical	modelling and actual numerical mod	els for the sir	mulation of flows a
	waves.			
Skills	Students are able to apply hydrodynamic-numerical models	to practical hydraulic engineering ta	ckc	
JKIIIS	students are usic to apply hydrodynamic-namencul models	to practical hydraulic engineering ta	585.	
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in	simple applied problems. Additionaly	, they will be	able to work in tea
	with others.			
Autonomy	The students will be able to independently extend their kno	wledge and apply it to new problems		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 3 hours. The examination	ation includes tasks with respect to	the general ι	understanding of t
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Electronic	ctive Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering:	Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Electiv	ve Compulsory		
	Civil Engineering: Specialisation Computational Engineering	Compulson		

Course L0813: Hydraulic Mod	Course L0813: Hydraulic Models	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Peter Fröhle	
Language	DE/EN	
Cycle	SoSe	
Content	<ul> <li>Fundamentals of hydraulic models</li> <li>Model laws</li> <li>Pi theorem of Buckingham</li> <li>Practical examples of hydraulic models</li> </ul>	
Literature	Strobl, Zunic: Wasserbau, Kap. 11 Hydraulische Modelle, Springer	

Course L0812: Modelling of	Waves
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>Waves, interactions with shallow water and constructions</li> <li>Wave theories</li> <li>Sea state and surges</li> <li>Development of waves</li> <li>Wave spectra</li> <li>Modelling of Waves / phase averaged and phase resolved models</li> <li>Application of a phase averaged model for wave prediction (SWAN)</li> <li>Application of phase resolved wave models (Mike)</li> </ul>
Literature	Vorlesungsumdruck

Course L0810: Modelling of F	Flow in Rivers and Estuaries
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Edgar Nehlsen, Prof. Peter Fröhle
Language	EN
Cycle	
	Introduction to numerical flow modelling
	<ul> <li>Processes affecting tht flow</li> <li>Examples and applications of numerical models</li> <li>Procedure of numerical modelling</li> <li>Model concept</li> </ul> Basic equations of hydrodynamics
	Saint-Venant equations
	Euler Equations
	Navier-Stokes equations
	Reynolds-averaged Navier-Stokes equations
	Shallow water equations
	Solving schemes
	Numerical discretization
	Solution algorithms
	Convergence
Literature	Vorlesungsskript
	Literaturempfehlungen
	Bund der Ingenieure für Wasserwirtschaft, Abfallwirtschaft und Kulturbau (1997): Hydraulische Berechnung von naturnahen
	Fließgewässern. Düsseldorf: BWK (BWK-Merkblatt).
	Chow, Ven-te (1959): Open-channel Hydraulics. New York usw.: McGraw-Hill (McGraw-Hill Civil Engineering Series).
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019a): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 1: Geodaten in der Fließgewässermodellierung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-1).
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019b): Merkblatt DWA-M 543-2 Geodaten in de Fließgewässermodellierung Teil 2: Bedarfsgerechte Datenerfassung und -aufbereitung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-2).
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019c): Merkblatt DWA-M 543-3 Geodaten in de Fließgewässermodellierung - Teil 3: Aspekte der Strömungsmodellierung und Fallbeispiele. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-3).
	Hervouet, Jean-Michel (2007): Hydrodynamics of free surface flows. Modelling with the finite element method. Chichester: Wiley Online verfügbar unter http://www.loc.gov/catdir/enhancements/fy0741/2007296953-b.html.
	IAHR (2015): Professional Specifications for Physical and Numerical Studies in Environmental Hydraulics. In: Hydrolink (3/2015), S 90-92.
	Olsen, Nils Reidar B. (2012): Numerical Modelling and Hydraulics. 3. Aufl. Department of Hydraulic and Environmental Engineering The Norwegian University of Science and Technology.
	Szymkiewicz, Romuald (2010): Numerical modeling in open channel hydraulics. Dordrecht: Springer (Water science and technology library, 83).
	van Waveren, Harold (1999-): Good modelling practice handbook. [Utrecht], Lelystad, Den Haag: STOWA; Rijkswaterstaat-RIZA SDU, afd. SEO/RIZA [etc. distr.] (Nota, nr. 99.036).
	Zielke, Werner (Hg.) (1999): Numerische Modelle von Flüssen, Seen und Küstengewässern. Deutscher Verband für Wasserwirtschaft und Kulturbau. Bonn: Wirtschafts- und VerlGes. Gas und Wasser (Schriftenreihe des Deutschen Verbandes für Wasserwirtschaft und Kulturbau, 127).

Module M0874: Waste	ewater Systems				
-	-				
Courses					
Title		Ту		Hrs/wk	СР
Biological Wastewater Treatment (L0517)			cture	2	2
Biological Wastewater Treatment (			citation Section (large)	1 2	1 2
Advanced Wastewater Treatment ( Advanced Wastewater Treatment (			cture citation Section (large)	2	2
Module Responsible		ne	citation Section (large)	Ŧ	Ŧ
Admission Requirements	None				
	Knowledge of wastewater management	and the key processes invol	ved in wastewater treatr	nent	
Knowledge	Knowledge of wastewater management	and the key processes invol	ved in wastewater treati	nent.	
	After taking part successfully, students h	any reached the following l	oproing results		
	After taking part successfully, students h	lave reached the following i	earning results		
Professional Competence					
Knowledge	Students are able to outline key areas o	-	•	-	
	dependence for sustainable water protect	ction. They can describe rele	evant economic, environi	mental and social	factors.
Skills	Students are able to pre-design and explain the available wastewater treatment processes and the scope of their application i				
	municipal and for some industrial treatment plants.				
Personal Competence					
Social Competence	Social skills are not targeted in this mode	ule.			
Autonomy	Students are in a position to work on a	a subject and to organize t	their work flow indepen	dently They can	also present on th
, lacenemy	subject.		anen ment neu maepen		
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84			
Credit points					
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structur	ral Engineering: Elective Cor	mpulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Water and Traffic: Compulsory				
	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory				
	Environmental Engineering: Specialisation Water Quality and Water Engineering: Elective Compulsory				
	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory				
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory				
	Process Engineering: Specialisation Envi	ronmental Process Engineer	ing: Elective Compulsory	/	
	Process Engineering: Specialisation Proc	ess Engineering: Elective Co	ompulsory		
	Water and Environmental Engineering: S	Specialisation Water: Compu	llsory		
	Water and Environmental Engineering: S	Specialisation Environment:	Elective Compulsory		
	Water and Environmental Engineering: S	Specialisation Cities: Compu	lsory		

Course L0517: Biological Wastewater Treatment	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Joachim Behrendt
Language	DE/EN
Cycle	SoSe
Content	Charaterisation of Wastewater
	Metobolism of Microorganisms
	Kinetic of mirobiotic processes
	Calculation of bioreactor for wastewater treatment
	Concepts of Wastewater treatment
	Design of WWTP
	Excursion to a WWTP
	Biofilms
	Biofim Reactors
	Anaerobic Wastewater and sldge treatment
	resources oriented sanitation technology
	Future challenges of wastewater treatment
Literature	Gujer, Willi
	Siedlungswasserwirtschaft : mit 84 Tabellen
l	

ISBN: 3540343296 (Gb.) URL: http://www.gbv.de/dms/bs/toc/516261924.pdf URL: http://deposit.d-nb.de/cgi-bin/dokserv?
id=2842122&prov=M&dok_var=1&dok_ext=htm
Berlin [u.a.] : Springer, 2007
TUB_HH_Katalog
Henze, Mogens
Wastewater treatment : biological and chemical processes
ISBN: 3540422285 (Pp.)
Berlin [u.a.] : Springer, 2002
TUB_HH_Katalog
Imhoff, Karl (Imhoff, Klaus R.;)
Taschenbuch der Stadtentwässerung : mit 10 Tafeln
ISBN: 3486263331 ((Gb.))
München [u.a.] : Oldenbourg, 1999
TUB_HH_Katalog
Lange, Jörg (Otterpohl, Ralf; Steger-Hartmann, Thomas;)
Abwasser : Handbuch zu einer zukunftsfähigen Wasserwirtschaft
ISBN: 3980350215 (kart.) URL: http://www.gbv.de/du/services/agi/52567E5D44DA0809C12570220050BF25/000000700334
Donaueschingen-Pfohren : Mall-Beton-Verl., 2000
TUB_HH_Katalog
Mudrack, Klaus (Kunst, Sabine;)
Biologie der Abwasserreinigung : 18 Tabellen
ISBN: 382741427X URL: http://www.gbv.de/du/services/agi/94B581161B6EC747C1256E3F005A8143/420000114903
Heidelberg [u.a.] : Spektrum, Akad. Verl., 2003
TUB_HH_Katalog
Tchobanoglous, George (Metcalf & Eddy, Inc., ;)
Wastewater engineering : treatment and reuse
ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk))
Boston [u.a.] : McGraw-Hill, 2003
TUB_HH_Katalog
Henze, Mogens
Activated sludge models ASM1, ASM2, ASM2d and ASM3
ISBN: 1900222248
London : IWA Publ., 2002
TUB_HH_Katalog
Kunz, Peter
Umwelt-Bioverfahrenstechnik
Vieweg, 1992
Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung für
Wasserwirtschaft, Abwasser und Abfall, ;)
Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe
aus der Abwasserbehandlung, Kleinkläranlagen
ISBN: 3860682725 URL: http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf URL:
http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf
Weimar : Universitätsverl, 2006
TUB_HH_Katalog
Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall
DWA-Regelwerk
Hennef : DWA, 2004
TUB_HH_Katalog
Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;)
Fundamentals of biological wastewater treatment
ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm
Weinheim : WILEY-VCH, 2007
TUB_HH_Katalog

Course L3122: Biological Wa	Course L3122: Biological Wastewater Treatment	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Joachim Behrendt	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0357: Advanced Wa	stewater Treatment
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Joachim Behrendt
Language	EN
Cycle	SoSe
Content	Survey on advanced wastewater treatment
	reuse of reclaimed municipal wastewater
	Precipitation
	Flocculation
	Depth filtration
	Membrane Processes
	Activated carbon adsorption
	Ozonation
	"Advanced Oxidation Processes"
	Disinfection
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung,
	Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003

Course L0358: Advanced Wa	stewater Treatment
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Joachim Behrendt
Language	EN
Cycle	SoSe
Content	Aggregate organic compounds (sum parameters)
	Industrial wastewater
	Processes for industrial wastewater treatment
	Precipitation
	Flocculation
	Activated carbon adsorption
	Recalcitrant organic compounds
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003

Courses	
Title	Typ Hrs/wk CP
City Planning (L1066)	Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
	for "Principles of Urban Planning": none
Knowledge	for "Designing Urban Streetscapes": some knowledge of transport planning, e.g. through taking the undergraduate class "Tran
	Planning and Traffic Engineering"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to:
	use technical terms of urban planning.
	<ul> <li>describe the main determinants of urban development.</li> <li>evaluation and compare different percibilities of here urban development can be influenced.</li> </ul>
	<ul> <li>explain and compare different possibilities of how urban development can be influenced.</li> <li>discuss requirements for public streatscapes</li> </ul>
	<ul> <li>discuss requirements for public streetscapes.</li> <li>explain the importance of street design.</li> </ul>
	• explain the importance of street design.
Skills	Students are able to:
	<ul> <li>read and analyze urban development concepts and designs for streetscapes</li> </ul>
	appraise such concepts in the context of competing requirements.
	<ul> <li>design, justify and reflect their own solutions for concrete examples.</li> </ul>
Personal Competence	
Social Competence	Students are able to:
	discuss intermediate results with each other.
	<ul> <li>constructively accept feedback on their own work.</li> <li>provide constructive feedback to others.</li> </ul>
	• provide constructive reedback to others.
Autonomy	Students are able to:
,	
	<ul> <li>independently complete a written report including drawings following a broadly pre-defined process.</li> </ul>
	assess the consequences of their proposed solutions.
	<ul> <li>independently acquire knowledge and apply this to new issues or problem areas.</li> </ul>
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
-	
Course achievement	None Written elaboration
Examination duration and scale	written assignment, designwork during the semester
	Civil Engineering: Specialisation Structural Engineering: Elective Computers
-	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Compulsory

Course L1066: City Planning	
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	SoSe
Content	<ul> <li>"Principles of Urban Planning" deals with the determinants of urban development and their interactions. Topics include: <ul> <li>legal framework,</li> <li>instruments and methods of planning,</li> <li>functional requirements,</li> <li>stakeholders and actors</li> <li>basic design requirements</li> <li>different planning levels and</li> <li>historical contexts.</li> </ul> </li> <li>The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functional and aesthetic requirements for designing streetscape as the most important elements of public space.</li> <li>The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept, a building masterplan and a street redesign.</li> </ul>
Literature	Albers, Gerd; Wekel, Julian (2021) Stadtplanung: Eine illustrierte Einführung. 4. überarbeitete Auflage. Primus Verlag. Darmstadt.
	Frick, Dieter (2011) Theorie des Städtebaus: Zur baulich-räumlichen Organisation von Stadt. 3. veränderte Auflage. Wasmuth- Verlag. Tübingen
	Jonas, Carsten (2009) Die Stadt und ihr Grundriss. Wasmuth-Verlag. Tübingen Kostof, Spiro; Castillo, Greg (1998) Die Anatomie der Stadt. Geschichte städtischer Strukturen. Campus-Verlag. Frankfurt/New York.

-					
Courses					
Title	Тур	3	Hrs/wk	СР	
Construction Logistics (L1163)		ture	1	2	
Construction Logistics (L1164)		itation Section (small)	1	2	
Project Development and Managen Project Development and Managen		ture ject-/problem-based Learning	1	1	
		ect-problem-based Learning	T	1	
Module Responsible Admission Requirements	None				
Recommended Previous	none				
Knowledge	none				
	After taking part successfully, students have reached the following la	arning results			
	After taking part successfully, students have reached the following le				
Professional Competence	Studente con				
Knowledge	Students can				
	• give definitions of the main terms of construction logistics and	project development and ma	anagement		
	<ul> <li>name advantages and disadvantages of internal or external content</li> </ul>	onstruction logistics			
	<ul> <li>explain characteristics of products, demand and production of</li> </ul>	construction objects and the	eir consequer	nces for construction	
	specific supply chains				
	<ul> <li>differentiate constructions logistics from other logistics system</li> </ul>	15			
Skills	Students can				
	carry out project life cycle assessments				
	<ul> <li>apply methods and instruments of construction logistics</li> </ul>				
	<ul> <li>apply methods and instruments of project development and m</li> </ul>	lanagement			
	apply methods and instruments of conflict management				
	<ul> <li>design supply and waste removal concepts for a construction p</li> </ul>	project			
Personal Competence					
Social Competence	Students can				
	hold presentations in and for groups				
	<ul> <li>apply methods of conflict solving skills in group work and case</li> </ul>	studies			
Autonomy	Students can				
	<ul> <li>solve problems by holistic, systemic and flow oriented thinking</li> </ul>				
	<ul> <li>improve their creativity, negotiation skills, conflict and crise studies</li> </ul>	s solution skills by applying	methods of	moderation in ca	
	studies				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6				
Course achievement	None				
Examination	Written elaboration				
Examination duration and	Two written papers with presentations				
scale					
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Com	ipulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective C	Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compu	lsory			
	Civil Engineering: Specialisation Water and Traffic: Elective Compulse	ory			
	International Management and Engineering: Specialisation II. Civil En	gineering: Elective Compulso	ory		
	International Management and Engineering: Specialisation II. Logistic	s: Elective Compulsory			
	Logistics, Infrastructure and Mobility: Specialisation Production and Lo	ogistics: Elective Compulsory	/		
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and	d Mobility: Elective Compulso	ory		

Course L1163: Construction	Logistics
Тур	Lecture
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig
Language	DE
Cycle	SoSe
Content	The lecture gives deeper insight how important logistics are as a competetive factor for construction projects and which issues are to be adressed. The following toppics are covered: • competetive factor logistics • the concept of systems, planning and coordination of logistics • material, equipment and reverse logistics • IT in construction logistics • elements of the planning model of construction logistics and their connections • flow oriented logistics systems for construction projects • logistics concepts for ready to use construction projects (especially procurement and waste removel logistics) • best practice examples (construction logistics Potsdamer Platz, recent case study of the region) Contents of the lecture are deepened in special exercises.
Literature	Flämig, Heike: Produktionslogistik in Stadtregionen. In: Forschungsverbund Ökologische Mobilität (Hrsg.) Forschungsbericht Bd 15.2. Wuppertal 2000. Krauss, Siri: Die Baulogistik in der schlüsselfertigen Ausführung, Bauwerk Verlag GmbH Berlin 2005. Lipsmeier, Klaus: Abfallkennzahlen für Neubauleistungen im Hochbau : Verlag Forum für Abfallwirtschaft und Altlasten, 2004. Schmidt, Norbert: Wettbewerbsfaktor Baulogistik. Neue Wertschöpfungspotenziale in der Baustoffversorgung. In: Klaus, Peter Edition Logistik. Band 6. Deutscher Verkehrs-Verlag. Hamburg 2003. Seemann, Y.F. (2007): Logistikkoordination als Organisationseinheit bei der Bauausführung Wissenschaftsverlag Mainz in Aachen, Aachen. (Mitteilungen aus dem Fachgebiet Baubetrieb und Bauwirtschaft (Hrsg. Kuhne, V.): Heft 20)

Course L1164: Construction	Course L1164: Construction Logistics		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Heike Flämig		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1161: Project Develo	ourse L1161: Project Development and Management		
Тур	Lecture		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei		
Language	DE		
Cycle	SoSe		
Content	Within the lecture, the main aspects of project development and management are tought:		
	Terms and definitions of project management		
	<ul> <li>Advantages and disadvantages of different ways of project handling</li> </ul>		
	<ul> <li>organization, information, coordination and documentation</li> </ul>		
	cost and fincance management in projects		
	<ul> <li>time- and capacity management in projects</li> </ul>		
	<ul> <li>specific methods and instruments for successful team work</li> </ul>		
	Contents of the lecture are deepened in special exercises.		
Literature	Projektmanagement-Fachmann. Band 1 und Band 2. RKW-Verlag, Eschborn, 2004.		

Course L1162: Project Devel	rse L1162: Project Development and Management			
Тур	Project-/problem-based Learning			
Hrs/wk	1			
СР	1			
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei			
Language	DE			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

-					
Courses					
Title		Тур	Hrs/wk	СР	
Structural Dynamics (L1202)		Lecture	2	2	
Structural Dynamics (L1203)		Recitation Section (large)	2	2	
Fracture mechanics and fatigue in		Lecture	1	1	
Fracture mechanics and fatigue in		Recitation Section (large)	1	1	
	Prof. Bastian Oesterle				
Admission Requirements					
Recommended Previous	Knowledge of linear structural analysis of	of statically determinate and indeterminate structu	ures; Mechanics	I/II, Mathematics	
Knowledge	Differential equations I				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results			
Professional Competence					
•		le the student can evaluin the basic aspects of d	unamia offecta a	n structures and	
Kilowiedge	respective methods.	lle, the student can explain the basic aspects of d	ynanne enects e	in sciuctures and	
Skille	After successful completion of this may	dule, the students will be able to predict the res	nonco of motor	al and structures	
381115			ponse or mater		
	dynamics loading using the appropriate co	omputational approaches and methods.			
Personal Competence					
Social Competence	Students can				
	<ul> <li>participate in subject specific and i</li> </ul>	nterdicciplinary discussions			
	<ul> <li>participate in subject-specific and interdisciplinary discussions,</li> <li>defend their own work results in front of others.</li> </ul>				
	defend their own work results in front of others				
	promote the scientific development of colleagues				
	<ul> <li>Furthermore, they can give and accord</li> </ul>	cept professional constructive criticism			
Autonomu	Students are able to gain knowledge of the	ne subject area from given and other sources and a	pply it to new pr	oblems. Furthermo	
Autonomy	they are able to structure the solution process for problems in the area of Structural Analysis.				
Autonomy	they are able to structure the solution pro				
		ocess for problems in the area of Structural Analysis.			
	they are able to structure the solution pro Independent Study Time 96, Study Time i	ocess for problems in the area of Structural Analysis.			
	Independent Study Time 96, Study Time i	ocess for problems in the area of Structural Analysis.			
Workload in Hours	Independent Study Time 96, Study Time i 6	ocess for problems in the area of Structural Analysis.			
Workload in Hours Credit points Course achievement	Independent Study Time 96, Study Time i 6	ocess for problems in the area of Structural Analysis.			
Workload in Hours Credit points Course achievement	Independent Study Time 96, Study Time i 6 None Written exam	ocess for problems in the area of Structural Analysis.			
Workload in Hours Credit points Course achievement Examination	Independent Study Time 96, Study Time i 6 None Written exam	ocess for problems in the area of Structural Analysis.	· 		
Workload in Hours Credit points Course achievement Examination Examination duration and scale	Independent Study Time 96, Study Time i 6 None Written exam	ocess for problems in the area of Structural Analysis. n Lecture 84			
Workload in Hours Credit points Course achievement Examination Examination duration and scale	Independent Study Time 96, Study Time i 6 None Written exam 150 min Civil Engineering: Specialisation Structura	n Lecture 84			
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time i 6 None Written exam 150 min Civil Engineering: Specialisation Structura	n Lecture 84 n Lecture 84 Il Engineering: Compulsory nical Engineering: Elective Compulsory			
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time i 6 None Written exam 150 min Civil Engineering: Specialisation Structura Civil Engineering: Specialisation Geotechr Civil Engineering: Specialisation Coastal E	n Lecture 84 n Lecture 84 n Engineering: Compulsory nical Engineering: Elective Compulsory ingineering: Elective Compulsory			
Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Independent Study Time 96, Study Time i 6 None Written exam 150 min Civil Engineering: Specialisation Structura Civil Engineering: Specialisation Geotechr	n Lecture 84 n Lecture 84 al Engineering: Compulsory nical Engineering: Elective Compulsory ingineering: Elective Compulsory d Traffic: Elective Compulsory			

Course L1202: Structural Dy	namics		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	DE		
Cycle	SoSe		
Content	<ul> <li>mechanical background of dynamics</li> <li>harmonic vibrations, damped and undamped free and forced vibrations</li> <li>frequency and time domain</li> <li>modelling aspects</li> <li>principle of d'Alembert</li> <li>systems with multiple degrees of freedom</li> <li>consistent and lumped mass matrices</li> <li>finite elements for dynamics problems</li> <li>impact problems</li> <li>eigenvalue problems and modal analysis</li> <li>direct time integration schemes, transient analyses</li> </ul>		
Literature	<ul> <li>Vorlesungsmanuskript</li> <li>Clough, R.W., Penzien, J.: Dynamics of Structures. 2. Aufl., McGraw-Hill, New York, 1993.</li> </ul>		

Course L1203: Structural Dy	Course L1203: Structural Dynamics		
Тур	Recitation Section (large)		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Jürgen Priebe
Language	DE
Cycle	SoSe
Content	<ul> <li>basics of fatigue stress and fatigue resistance and determination of fatigue strength,</li> </ul>
	<ul> <li>determination and use of S-N-curves and classification of notch effects,</li> </ul>
	• set up of determination of fatigue strength under dynamic load using the accumulation formula by Palmgren-Miner,
	<ul> <li>set up of determination of fatigue strength in different examples,</li> </ul>
	<ul> <li>basics of construction and design regarding the problem of material fatigue,</li> </ul>
	basics of linear elastic fracture mechanics under static and dynamic load,
	determination of lifetime of steel construction based on linear elastic fracture mechanics in different examples.
Literature	Seeßelberg, C.; Kranbahnen - Bemessung und konstruktive Gestaltung; 3. Auflage; Bauwerk-Verlag; Berlin 2009
	• Kuhlmann, Dürr, Günther; Kranbahnen und Betriebsfestigkeit; in Stahlbau Kalender 2003; Verlag Ernst & Sohn; Berlin 200
	Deutscher Stahlbau-Verband (Hrsg.); Stahlbau Handbuch Band 1 Teil B; 3. Auflage; Stahlbau-Verlagsgesellschaft; Köln 19
	Petersen, C.; Stahlbau; 3. überarb. und erw. Auflage; Vieweg-Verlag; Braunschweig 1993
	<ul> <li>DIN V ENV 1993-1-1: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 1-1: Allgemeine Bemessungsr</li> <li>Bemessungsregeln f ür den Hochbau; 1993</li> </ul>
	• DIN V ENV 1993-6: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 6: Kranbahnen; 2001
	DIN-Fachbericht 126. Richtlinie zur Anwendung von DIN V ENV 1993-6; Nationales Anwendungsdokument (NAD); Berlin 2

Course L0565: Fracture mechanics and fatigue in steel structures		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Jürgen Priebe	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

## Module M0593: Building Materials and Building Preservation

Courses						
Title			Тур		Hrs/wk	СР
Repair of Structures (L0255)			Lecture		1	1
Mineral Building Materials (L0253)			Lecture		2	2
Technology of mineral Building Mat	erials (L0256)		Project-/problem-	based Learning	1	2
Transport Processes in Building Ma	erials and Damage Processes (L02	254)	Lecture		1	1
Module Responsible	Prof. Frank Schmidt-Döhl					
Admission Requirements	None					
<b>Recommended Previous</b>	Basic knowledge about building materials, building physics and building chemistry, for example by the modules Principles of					
Knowledge	Building Materials and Building Physics and Building Materials and Building Chemistry.					
Educational Objectives	After taking part successfully,	students have reach	ed the following learning result	ts		
Professional Competence						
Knowledge	The students are able to descr	ibe the components	of mineral building materials a	nd their function	in detail and	d to use them for t
	manufacture of special minera	l building materials.	They are able to show the cha	racteristics of mi	neral building	g materials. They a
	able to describe the manufactu	ire, properties and f	ields of application of special n	nortars and spec	ial concretes	and the correlation
	of their material parameters. T	hey are able to show	v the principles of anchor techr	nology and desig	n.	
Chille	The students are able to perfe	m on optimization of	of aronulomotry of a minoral h	uilding material	They are abl	a ta dacian a chac
SKIIIS	The students are able to perform		• •	-		• ·
	mineral mortar and to manufacture this mortar. The students are able to manufacture post installed rebar conr				-	
	able to recognize damages, to assess possible causes, to use the fundamentals of construction preservation and to and strengthening measures.			and to select rep		
Personal Competence						
Social Competence	The students are able to devel					
	other students. In a critical discussion they defend and adjust their results. The students are able to manufacture their spec					
	building material on the basis of	of this feedback.				
Autonomy	my The students are able to responsibly use the resources of materials and lab equipment for their project and to investigate and					
	get missing components.					
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70					
Credit points	6					
Course achievement	Compulsory Bonus Form		Description			
	Yes 20 % Subject	theoretical and	1			
	practica	al work				
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	Civil Engineering: Specialisatio	n Geotechnical Engi	neering: Compulsory			
Following Curricula	Civil Engineering: Specialisatio	n Coastal Engineerin	g: Elective Compulsory			
	Civil Engineering: Specialisatio	n Structural Enginee	ring: Elective Compulsory			
	Civil Engineering: Specialisatio					

Course L0255: Repair of Stru	Course L0255: Repair of Structures		
Тур	Lecture		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Frank Schmidt-Döhl		
Language	DE		
Cycle	SoSe		
Content	Maintenance of structures, repair and strengthening, subsequent waterproofing of structures		
Literature	BetonMarketing Deutschland (Hrsg.): Stahlbetonoberflächen - schützen, erhalten, instandsetzen		

Course L0253: Mineral Buildi	ing Materials
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	SoSe
Content	Components of mineral building materials and their function, binding materials, concrete and mortar, special mortars, special concretes
Literature	Taylor, H.F.W.: Cement Chemistry
	Springenschmid, R.: Betontechnologie für die Praxis

Course L0256: Technology of	Course L0256: Technology of mineral Building Materials	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Design and production of a special mineral building material	
Literature	Taylor, H.F.W.: Cement Chemistry	
	Springenschmid, R.: Betontechnologie für die Praxis	

Course L0254: Transport Pro	Course L0254: Transport Processes in Building Materials and Damage Processes	
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Transport Processes in Building Materials and Damage Processes	
Literature	Blaich, J.: Bauschäden, Analyse und Vermeidung	

Courses				
<b>Fitle</b>		Тур	Hrs/wk	СР
Steel Construction Project (L1206)		Project Seminar	4	6
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
<b>Recommended Previous</b>	Steel and Composite Structures			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Students are able to prepare a part of the	whole project and explain it to the others.		
Skills	Students can produce sketches and calc	ulations of their part of the project. They ar	e able to adjust their	work in reaction
	changing conditions resulting from other p	articipants of the project.		
Personal Competence				
Social Competence	Students can present their results to other members of the group.			
	They have the ability to work for a broad a	greement with respect to intergroup depende	encies.	
	They can distribute and process tasks inde	ependently.		
Autonomy	Students can handle their part of the proje	ect on their own resposibility-		
Workload in Hours	Independent Study Time 124, Study Time	in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	approx. 15-20 pages (without appendix)			
scale				
Assignment for the	Civil Engineering: Specialisation Geotechn	ical Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal E			
	Civil Engineering: Specialisation Structura			
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory		

Course L1206: Steel Constru	Course L1206: Steel Construction Project	
Тур	Project Seminar	
Hrs/wk	4	
CP	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Marcus Rutner	
Language	DE	
Cycle	SoSe	
Content	Design of a big construction project (i.e skyscraper, large bridge, roof of a stadiuim) in small groups	
Literature	Wird je nach Projekt individuell angegeben.	
1		

Courses				
Title		Тур	Hrs/wk	СР
Marine Geotechnics (L0548)		Lecture	1	2
Marine Geotechnics (L0549) Steel Structures in Foundation and	Hydraulic Engineering (11146)	Recitation Section (large) Lecture	2	2
Module Responsible		20000	-	-
Admission Requirements				
	Complete modules: Geotechnics I-III, Math	ematics I-III		
Knowledge	•			
	Courses: Soil laboratory course			
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	The students get a deeper knowledge of steel and ground engineering as well as constructions knowledge concerning quay wa			
Furthermore, the students get all the necessary knowledge to design singular construction elements for she		elements for shee	et pile walls and th	
	know how to choose the right construction	elements depending on the influencing conditions		
Skille	a Furthermore the students are able to dimension sheet allo well construction reporting - "			ments to choose t
JKIIIS	ills Furthermore, the students are able to dimension sheet pile wall construction regarding all construction elements, to suitable construction elements with respect to the influencing conditions, to design all kinds of sheet pile walls (wave			
		o dimension all construction elements and connect		
Personal Competence				
Social Competence				
Autonomy	Students are able to assess their own stren	ngths and weaknesses and organize their time and	learning manage	ement based on th
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Geotechni	ical Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Er	ngineering: Compulsory		
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory		

Course L0548: Marine Geotechnics	
Тур	Lecture
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	<ul> <li>Geotechnical investigation an description of the seabed</li> <li>Foundations of Offshore-Constructions</li> <li>cCliff erosion</li> <li>Sea dikes</li> <li>Port structures</li> <li>Flood protection structures</li> </ul>
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst &amp; Sohn, Berlin</li> </ul>

## Module Manual M.Sc. "Civil Engineering"

Course L0549: Marine Geote	urse L0549: Marine Geotechnics	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Jürgen Grabe	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1146: Steel Structur	Course L1146: Steel Structures in Foundation and Hydraulic Engineering	
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Frank Feindt	
Language	DE	
Cycle	SoSe	
Content	Design of a sheet pile wall, design of a combined sheet pile wall, piles, walings, connections, fatigue	
Literature	EAU 2012, EA-Pfähle, EAB	

Courses				
Title		Тур	Hrs/wk	СР
Smart Monitoring (L2762)		Integrated Lecture	2	2
Smart Monitoring (L2763)		Recitation Section (small)	2	4
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
Recommended Previous	Basic knowledge or interest in object-oriented modeling	, programming, and sensor technol	ogies are helpful	. Interest in mod
Knowledge				
	skills of scientific working, are required. Basic knowledge in scientific writing and good English skills.			
		Collection to contract the		
	After taking part successfully, students have reached the	following learning results		
Professional Competence	The students will become familiar with the principles	and practices of smart monitoring	The students wi	II ha abla ta da
Kilowiedge	The students will become familiar with the principles decentralized smart systems to be applied for contin			
	environment. In addition, the students will learn to desid			
	analysis techniques, modern software design concepts, a		, ,	
	also part of this module, which will be conducted throu			
	students will design smart monitoring systems that integ			
	Specific focus will be put on the application of machine			
	real-world (built or natural) systems, such as bridges or			
	every group will be documented in a paper. All students	of this module will "automatically" pa	articipate with th	eir smart monito
	system in the annual "Smart Monitoring" competition. The	e written papers and oral examination	ons form the final	grades. The mo
	will be taught in English. Limited enrollment.			
Skille	The students will gain insights into operating state-of-th	a art smart sonsor systems used for	monitoring a wi	de range of phys
SKIIIS	processes relevant to engineering, such as environme			
	devising monitoring strategies of physical processes as			
	implement the strategies in smart wireless sensor node:			
	be able to document the findings of their projects in sho		- <u>j</u>	,,,
Personal Competence				
Social Competence	The students will be able to work in groups, share parts	of the work for their projects, and de	evelop communic	cation skills, towa
	achieving the common project goals.			
Autonomy	The students will be able to gain a solid basis on appro	paching and solving problems in eng	ineering, as well	as on documen
	results, through their involvement in their monitoring gro	oup projects.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
	Written elaboration			
	10 pages of work with 15-minute oral presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Electi	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineerin	g: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Ele	ctive Compulsory		
	Civil Engineering: Specialisation Structural Engineering:	Elective Compulsory		
	Computer Science: Specialisation II: Intelligence Enginee	ring: Elective Compulsory		
	Environmental Engineering: Specialisation Energy and Re	esources: Elective Compulsory		
	Environmental Engineering: Specialisation Environment	and Climate: Elective Compulsory		
	Environmental Engineering: Specialisation Water Quality	and Water Engineering: Elective Com	npulsory	
	Mechatronics: Technical Complementary Course: Elective	e Compulsory		
	Mechatronics: Core Qualification: Elective Compulsory			
	Theoretical Mechanical Engineering: Specialisation Robo		Compulsory	
	Water and Environmental Engineering: Specialisation Cit			
	Water and Environmental Engineering: Specialisation En			
	Water and Environmental Engineering: Specialisation Wa			

Course L2762: Smart Monito	ring
Тур	Integrated Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	SoSe
Content	In this course, principles of smart monitoring will be taught, focusing on modern concepts of data acquisition, data storage, and data analysis. Also, fundamentals of intelligent sensors and embedded computing will be illuminated. Autonomous software and decentralized data processing are further crucial parts of the course, including concepts of the Internet of Things, Industry 4.0 and cyber-physical systems. Furthermore, measuring principles, data acquisition systems, data management and data analysis algorithms will be discussed. Besides the theoretical background, numerous practical examples will be shown to demonstrate how smart monitoring may advantageously be used for assessing the condition of systems in the built or natural environment.
Literature	The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course. However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online.

Course L2763: Smart Monito	ring
	Recitation Section (small)
Hrs/wk	
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	SoSe
	The contents of the exercises are based on the lecture contents. In addition to the exercises, project work will be conducted throughout the semester, which will consume the majority of the workload. As part of the project work, students will design smart monitoring systems that will be tested in the laboratory or in the field. As mentioned in the module description, the students will participate in the "Smart Monitoring" competition, hosted annually by the Institute of Digital and Autonomous Construction. Students are encouraged to contribute their own ideas. The tools required to implement the smart monitoring systems will be taught in the group exercises as well as through external sources, such as video tutorials and literature. The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course.
	However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online.

Courses					
Title		Тур	Hrs/wk	СР	
Offshore Geotechnical Engineering	(L0067)	Lecture	1	1	
Hydro Power Use (L0013)		Lecture	1	1	
Wind Turbine Plants (L0011)		Lecture	2	3	
Wind Energy Use - Focus Offshore	.L0012)	Lecture	1	1	
Module Responsible	Dr. Marvin Scherzinger				
Admission Requirements					
	Module: Technical Thermodynamics I,				
Knowledge	Module: Technical Thermodynamics II,				
	Module: Fundamentals of Fluid Mechanics				
Educational Objectives	After taking part successfully, students have reach	hed the following learning results			
<b>Professional Competence</b>					
Kilowieuge	By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy us offshore conditions and can critical comment these aspects in consideration of current developments. Furthermore, they are a to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic proceed in the implementation of renewable energy projects in countries outside Europe.				
	Through active discussions of various topics within the seminar of the module, students improve their understanding a application of the theoretical background and are thus able to transfer what they have learned in practice.				
Skills	Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate a assess technically the resulting relationships in the context of dimensioning and operation of these energy systems. They car compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with in principle applied approach in Europe and can apply this procedure on exemplary theoretical projects.				
Personal Competence					
Social Competence	Students can discuss scientific tasks subjet-specif	ficly and multidisciplinary within a se	eminar.		
Autonomy	Students can independently exploit sources in the context of the emphasis of the lecture material to clear the contents of lecture and to acquire the particular knowledge about the subject area.				
Workload in Hours	Independent Study Time 110, Study Time in Lectu	ire 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	180 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structural Engine	ering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng				
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory				
	International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory				
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory				
	Product Development, Materials and Production: Specialisation Production: Elective Compulsory				
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory				
	Renewable Energies: Core Qualification: Compulsory				
	Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory				
	Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory				
			pulsory		
	Water and Environmental Engineering: Specialisat	tion Cities: Elective Compulsory			
		tion Cities: Elective Compulsory tion Environment: Elective Compulso			

Course L0067: Offshore Geot	echnical Engineering		
Тур	Lecture		
Hrs/wk	1		
СР			
Workload in Hours	ependent Study Time 16, Study Time in Lecture 14		
Lecturer	Dr. Jan Dührkop		
Language	DE		
Cycle	SoSe		
Content	<ul> <li>Overview and Introduction Offshore Geotechnics</li> <li>Introduction to Soil Mechanics</li> <li>Offshore soil investigation</li> <li>Focus on cyclical effects</li> <li>Geotechnical design of offshore foundations</li> <li>Monopiles</li> <li>Jackets</li> <li>Heavyweight foundations</li> <li>Geotechnical preliminary exploration for the use of lift boats and platforms</li> </ul>		
Literature	<ul> <li>Randolph, M. and Gourvenec, S (2011): Offshore Geotechnical Engineering. Spon Press.</li> <li>Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>BSH-Standard Baugrunderkundung für Offshore-Windenergieparks</li> <li>Lesny K. (2010): Foundations for Offshore Wind Turbines. VGE Verlag, Essen.</li> <li>EA-Pfähle (2012): Empfehlungen des Arbeitskreises Pfähle der DGGT. Ernst &amp; Sohn, Berlin.</li> </ul>		

Course L0013: Hydro Power	Use
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Achleitner
Language	DE
Cycle	SoSe
Content	<ul> <li>Introduction, importance of water power in the national and global context</li> <li>Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies</li> <li>Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems</li> <li>Construction of hydroelectric power plants: description of the individual components and their technical system interaction</li> <li>Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc.</li> <li>Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection</li> <li>Hydropower and the Environment</li> <li>Examples from practice</li> </ul>
Literature	<ul> <li>Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage</li> <li>Quaschning, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage</li> <li>Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage</li> <li>von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage</li> <li>Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006</li> </ul>

Course L0011: Wind Turbine	Plants
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rudolf Zellermann
Language	DE
Cycle	SoSe
Content	<ul> <li>Historical development</li> <li>Wind: origins, geographic and temporal distribution, locations</li> <li>Power coefficient, rotor thrust</li> <li>Aerodynamics of the rotor</li> <li>Operating performance</li> <li>Power limitation, partial load, pitch and stall control</li> <li>Plant selection, yield prediction, economy</li> <li>Excursion</li> </ul>
Literature	Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005

Course L0012: Wind Energy	Use - Focus Offshore
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Skiba
Language	DE
Cycle	SoSe
Content	<ul> <li>Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering</li> <li>Physical fundamentals for utilization of wind energy</li> <li>Design and operation of offshore wind turbines, presentation of different concepts of offshore wind turbines, representation of the individual system components and their system-technical relationships</li> <li>Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures</li> <li>Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection</li> <li>Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics</li> <li>Development and planning of offshore wind farms</li> <li>Operation and optimization of offshore wind farms</li> <li>Day excursion</li> </ul>
Literature	<ul> <li>Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage</li> <li>Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidel-berg, 1997, 3. Auflage</li> <li>Hau, E.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage</li> <li>Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage</li> <li>Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage</li> </ul>

House Hoose. Coas	tal Hydraulic Engineering I			
Courses				
Title		Тур	Hrs/wk	СР
Basics of Coastal Engineering (L08		Lecture	3	4
Basics of Coastal Engineering (L14	13)	Project-/problem-based Lea	rning 1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of hydraulic engineering, hydrolog	y and hydromechanics		
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	The students are able to define and expla	ain the basic concepts of coastal engineering and	port engineering. T	hey are able to app
	the concepts to selected practical proble	ms of coastal engineering. Students can define a	and determine the I	pasics for design a
	dimensioning of coastal engineering cons	tructions.		
Skills	The students are capable to apply basic design approaches to selected and pre-defined design tasks in coastal engineering.			
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in applied problems such as the design of coastal protection structu			protection structure
,	Additionaly, they will be able to work in te	eam with engineers of other disciplines, for instan	ce designing of coa	stal breakwaters.
Autonomy	The students will be able to independent	y extend their knowledge and applyit to new prob	lems.	
	······································	,		
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 2 ho	ours. The examination includes tasks with respe	ct to the general u	understanding of the
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Coastal E	Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechr	nical Engineering: Compulsory		
	Civil Engineering: Specialisation Structura	al Engineering: Elective Compulsory		
		n Environment and Climate: Elective Compulsory		
		n Water Quality and Water Engineering: Elective C		
	5 5	ng: Specialisation II. Civil Engineering: Elective Co	mpulsory	
		pecialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Sp	pecialisation Water: Elective Compulsory		

Course L0807: Basics of Coas	Course L0807: Basics of Coastal Engineering			
Тур	Lecture			
Hrs/wk	3			
CP	4			
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42			
Lecturer	Prof. Peter Fröhle			
Language	EN			
Cycle	SoSe			
Content				
	Basics of planning and design			
	Water levels     Currents			
	Waves			
	• Ice			
	Planning and Design in Coastal Engineering			
	Functional and constructional design			
	<ul> <li>Determination of design parameters</li> </ul>			
	Design-approaches			
	Filter			
	<ul> <li>Rubble mound constructions</li> </ul>			
	Piles			
	<ul> <li>Vertical constructions</li> </ul>			
Literature	Coastal Engineering Manual, CEM			
	Vorlesungsumdruck			
	Vonesungsunnardek			

Course L1413: Basics of Coas	Irse L1413: Basics of Coastal Engineering			
Тур	Project-/problem-based Learning			
Hrs/wk	1			
СР	2			
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14			
Lecturer	Prof. Peter Fröhle			
Language	EN			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

Module M1845: Thin-	walled structures			
Module M1645. Thin-	walled structures			
Courses				
Title		Тур	Hrs/wk	СР
Thin-walled structures (L1199)		Lecture	2	3
Thin-walled structures (L3045)		Recitation Section (large)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Structural Analysis I</li> <li>Structural Analysis II</li> <li>Finite Element Methods</li> </ul>			
<b>Educational Objectives</b>	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, the st	udents can express the basic aspects of	the load-carryin	g behaviour of thin
	walled structures.			
Skills	After successful completion of this module, the students will be able to predict load-carrying behaviour of thin-walled str			
01110	using appropriate analytical and coputational metho			
Personal Competence				
Social Competence	Students can			
	<ul> <li>participate in subject-specific and interdisciple</li> </ul>	linary discussions,		
	<ul> <li>defend their own work results in front of other</li> </ul>	rs		
	<ul> <li>promote the scientific development of colleage</li> </ul>	gues		
	<ul> <li>Furthermore, they can give and accept profes</li> </ul>	- ssional constructive criticism		
Autonomy	Students are able to gain knowledge of the subject	÷ ,		
	they are able to structure the solution process for p	roblems in the area of modelling and analy	is of thin-walled	d structures.
Workload in Hours	Independent Study Time 124, Study Time in Lecture	2 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering	g: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engin	eering: Elective Compulsory		
	Civil Engineering: Specialisation Computational Eng	ineering: Compulsory		
	Civil Engineering: Specialisation Structural Engineer	ing: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation	Simulation Technology: Elective Compulsor	ſУ	

Тур	Lecture	
Hrs/wk		
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	Plates loaded in-plane	
	<ul> <li>Governing equations (equilibrium, kinematics, constitutive law)</li> </ul>	
	<ul> <li>Differential equation</li> </ul>	
	Airy stress function	
	Plane stress / plane strain	
	Structural behaviour of plates loaded in-plane	
	• finite elements for plates loaded in-plane, modelling apsects, interpretation and critical assessment of results	
	Plates in bending	
	Governing equations (equilibrium, kinematics, constitutive law)	
	Differential equation	
	Navier solution / Fourier series expansion	
	<ul> <li>Approximation procedures</li> <li>Circular and rectangular plates</li> </ul>	
	Structural behaviour of plates in bending	
	<ul> <li>finite elements for plates in bending, modelling apsects, interpretation and critical assessment of results</li> </ul>	
	Shells	
	Phenomenona of the structural behaviour of shells	
	Membrane and bending theory	
	Equilibrium equations of shells of revolution	
	Stress resultants and deformations of the spherical shell, the half spherical shell, and the cylindrical shell	
	finite elements for shells	
	Stability problems (overview)	
	Plate buckling	
	Shell buckling	
I :toust		
Literature	Vorlesungsmanuskript	
	• Basar, Y.: Krätzig, W.B. (1985): Mechanik der Flächentragwerke. Vieweg-Verlag, Braunschweig, Wiesbaden	
	Girkmann, K. (1963): Flächentragwerke, Springer Verlag, Wien, 1963, unveränderter Nachdruck 1986	
	• Zienkiewicz, O.C. (1977): The Finite Element Method in Enginieering Science. McGraw-Hill, London	

Course L3045: Thin-walled st	ourse L3045: Thin-walled structures		
Тур	Recitation Section (large)		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Water Protection and Wastewater Management (L0226)		Lecture	3	3
Water Protection and Wastewater I	-	Project Seminar	3	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	<ul> <li>Basic knowledge in water management</li> </ul>	t;		
Knowledge	<ul> <li>Good knowledge in urban drainage;</li> </ul>			
	Good knowledge of wastewater treatment	ent techniques;		
	<ul> <li>Good knowledge of pollutants (e.g. COI</li> </ul>	D, BOD, TS, N, P) and their properties;		
Educational Objectives	After taking part successfully, students have r	reached the following learning results		
Professional Competence	Arter taking part successivity, stadents have i	cached the following learning results		
•	The students can describe the basic principle	s of the regulatory framework related to th	e international and Eu	Iropean water secto
	They can explain limnological processes, su			
	problems related to water protection, such a			
	solutions, remediation measures as well as co	nceptual approaches.		
Cl://-	Chudanta and a sumboly and a sum of model		least sentent. Then	
SKIIIS	Students can accurately assess current probl actions to contribute to the planning of ton		-	
	administrative and legislative solutions to solu		they can suggest a	ppropriate technica
		ve triese problems.		
Personal Competence				
Social Competence	The students can work together in internation	al groups.		
Autonomv	Students are able to organize their work flow	to prepare presentations and discussions	. They can acquire ap	propriate knowled
	by making enquiries independently.		- <b>7</b>	
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84		
Credit points	6			
Course achievement	None			
Examination				
	Term paper plus presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural En	gineering: Elective Compulsory		
Following Curricula				
-	Civil Engineering: Specialisation Coastal Engir	neering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Tr	affic: Elective Compulsory		
	Environmental Engineering: Specialisation Wa	ter Quality and Water Engineering: Elective	e Compulsory	
	International Management and Engineering: S	pecialisation II. Civil Engineering: Elective	Compulsory	
	Water and Environmental Engineering: Specia	lisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Specia	lisation Water: Elective Compulsory		
	Water and Environmental Engineering: Specia	lisation Environment: Compulsory		

Course L0226: Water Protect	tion and Wastewater Management
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
	<ul> <li>The lecture focusses on:</li> <li>Regulatory Framework (e.g. WFD)</li> <li>Main instruments for the water management and protection</li> <li>In depth knowledge of relevant measures of water pollution control</li> <li>Urban drainage, treatment options in different regions on the world</li> <li>Rainwater management, improved management of heavy rainfalls, downpours, rainwater harvesting, rainwater infiltration</li> <li>Case Studies and Field Trips</li> </ul>
Literature	<ul> <li>The literature listed below is available in the library of the TUHH.</li> <li>Water and wastewater technology Hammer, M. J. 1., &amp; . (2012). (7. ed., internat. ed.). Boston [u.a.]: Pearson Education International.</li> <li>Water and wastewater engineering : design principles and practice: Davis, M. L. 1. (2011) New York, NY: McGraw-Hill.</li> <li>Biological wastewater treatment: (2011). C. P. Leslie Grady, Jr. (3. ed.). London, Boca Raton, Fla. [u.a.]: IWA Publ.</li> </ul>

Course L2008: Water Protect	Course L2008: Water Protection and Wastewater Management	
Тур	Project Seminar	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	WiSe	
Content		
Literature		

Courses				
Title		Тур	Hrs/wk	СР
Examination of Materials, Structura	l Condition and Damages (L0260)	Lecture	3	4
Examination of Materials, Structura	I Condition and Damages (L0261)	Recitation Section (small)	1	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge about building materials or ma	aterial science, for example by the mod	ule Building Ma	terials and Buildin
Knowledge	Chemistry.			
Educational Objectives	After taking part successfully, students have reached	ed the following learning results		
Professional Competence				
Knowledge	The students are able to describe the rules for trading, use and marking of construction products in Germany. They know whic methods for the testing of building material properties are usable and know the limitations and characterics of the most important testing methods.			
Skills	The students are able to responsibly discover the rules for trading and using of building products in Germany. They are able to chose suitable methods for the testing and inspection of construction products, the examination of damages ar the examination of the structural conditions of buildings. They are able to conclude from symptons to the cause of damages. The are able to describe an examination in form of a test report or expert opinion.			
Personal Competence Social Competence	The students can describe the different roles of manufacturers as well as testing, supervisory and certification bodies within t		on bodies within th	
	framework of material testing. They can describe th			
Autonomy			edge of a very e	xtensive field.
	Independent Study Time 124, Study Time in Lectur	e 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Enginee	ring: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engir	neering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineerin	g: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic:	Elective Compulsory		
	International Management and Engineering: Specia	lisation II. Civil Engineering: Elective Comp	ulsory	
	Materials Science and Engineering: Specialisation E	ngineering Materials: Elective Compulsory		
	Materials Science: Specialisation Engineering Mater	ials: Elective Compulsory		

Course L0260: Examination of	Course L0260: Examination of Materials, Structural Condition and Damages		
Тур	Lecture		
Hrs/wk	3		
СР	4		
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
Lecturer	Prof. Frank Schmidt-Döhl		
Language	DE		
Cycle	WiSe		
Content	Materials testing and marking process of construction products, testing methods for building materials and structures, testing		
	reports and expert opinions, describing the condition of a structure, from symptons to the cause of damages		
Literature	Frank Schmidt-Döhl: Materialprüfung im Bauwesen. Fraunhofer irb-Verlag, Stuttgart, 2013.		

Course L0261: Examination of	ourse L0261: Examination of Materials, Structural Condition and Damages		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Frank Schmidt-Döhl		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
oining of Polymer-Metal Lightweig	ht Structures (L0500)	Lecture	2	2
oining of Polymer-Metal Lightweig		Practical Course	1	1
Metallic Light-weight Materials (L16	560)	Lecture	2	3
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students h	nave reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
, Autonomy				
Workload in Hours	Independent Study Time 110, Study Tim	e in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	45 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structur	al Engineering: Elective Compulsory		
Following Curricula	Materials Science and Engineering: Spec	ialisation Engineering Materials: Elective Comp	ilsory	
-	Materials Science: Specialisation Engine	ering Materials: Elective Compulsory		
	Theoretical Mechanical Engineering: Spe	vialisation Materials Science: Elective Compuls	201	

<ul> <li>technologies and its main fields of applications is to be accomplished through theoretical and practical lectures.</li> <li>Theoretical Lectures: <ul> <li>Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in Joining Technology</li> <li>Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics</li> <li>Mechanical Fastening of Polymer-Metal Hybrid Structures</li> <li>Adhesive Bonding of Polymer-Metal Hybrid Structures</li> <li>Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures</li> <li>Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures</li> </ul> </li> <li>Laboratory Exercises: <ul> <li>Joining Processes: Introduction to state-of-the-art joining technologies</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints</li> </ul> </li> </ul>		ymer-Metal Lightweight Structures			
CP       2         Workload in Hours       Independent Study Time 32, Study Time in Lecture 28         Lecturer       Prof. Marcus Rutner         Language       EN         Cycte       WiSe         Content       Contents:         The lecture and the related laboratory exercises intend to provide an insight on advanced joining technologies for polymer-m lightweight structures used in engineering applications. A general understanding of the principles of the consolidated and technologies and its main fields of applications is to be accomplished through theoretical and practical lectures.         Theoretical Lectures: <ul> <li>Review of the relevant properties of Lightweight Alloys. Engineering Plastics and Composites in Joining Technology</li> <li>Introduction to Welding of Lightweight Alloys. Thermoplastics and Fiber Reinforced Plastics</li> <li>Mechanical Fastening of Polymer-Metal Hybrid Structures</li> <li>Adhesive Bonding of Polymer-Metal Hybrid Structures</li> <li>Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures</li> <li>Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures</li> <li>Joining Processes: Introduction to state-of-the-art joining technologies</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints</li> </ul> <li>Laboratory Exercises:         <ul> <li>Joining Processes: Introduction to state-of-the-art joining technologies</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints<!--</th--><th></th><th></th></li></ul></li>					
Workload in Hours         Independent Study Time 32, Study Time in Lecture 28           Lecturer         Prof. Marcus Rutner           Language         EN           Cycle         WiSe           Content         Contents:           The lecture and the related laboratory exercises intend to provide an insight on advanced joining technologies for polymer-m lightweight structures used in engineering applications. A general understanding of the principles of the consolidated and technologies and its main fields of applications is to be accomplished through theoretical and practical lectures.           Theoretical Lectures: <ul> <li>Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in Joining Technology</li></ul>					
Lecturer       Prof. Marcus Ruther         Language       EN         Cycle       WiSe         Content       Contents:         The lecture and the related laboratory exercises intend to provide an insight on advanced joining technologies for polymer-metal ightweight structures used in engineering applications. A general understanding of the principles of the consolidated and technologies and its main fields of applications is to be accomplished through theoretical and practical lectures.         Theoretical Lectures: <ul> <li>Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in joining Technology</li> <li>Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics</li> <li>Adhesive Bonding of Polymer-Metal Hybrid Structures</li> <li>Adhesive Bonding of Polymer-Metal Hybrid Structures</li> <li>Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures</li> <li>Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures</li> <li>Joining Processes: Introduction to state-of-the-art joining technologies</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints</li> </ul> <li>Course Outcomes:</li> <li>After successful completion of this unit, students should be able to understand the principles of welding and joining of polymetal lightweight structures as well as their application fields.</li> <li>J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International</li> <li>J. Rothelser, Jeining of Plastics, AnadDoox for designers and engineers, Hanser Publishers&lt;</li>					
Language       EN         Cycle       WiSe         Content       Contents:         The lecture and the related laboratory exercises intend to provide an insight on advanced joining technologies for polymer-m lightweight structures used in engineering applications. A general understanding of the principles of the consolidated and technologies and its main fields of applications is to be accomplished through theoretical and practical lectures.         Theoretical Lectures: <ul> <li>Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in Joining Technology</li> <li>Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics</li> <li>Mechanical Fastening of Polymer-Metal Hybrid Structures</li> <li>Adhesive Bonding of Polymer-Metal Hybrid Structures</li> <li>Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures</li> <li>Isoining Processes: Introduction to state-of-the-art joining technologies</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints</li> <li>Course Outcomes:</li> <li>After successful completion of this unit, students should be able to understand the principles of welding and joining of polymertal lightweight structures as well as their application fields.</li> <li>I. S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018</li> <li>J. F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International</li> <li>J. Rotheiser, Jeining of Plastics, Andbook for designers and angineers, Hanser Publishers</li> <li>D.A. Grewell, A. Benatari, J.B. Park, Plastics and Composites Welding Handbook</li> <li>D. Lohwasser, Z. Chen,</li></ul>					
Cycle       WiSe         Contents:       The lecture and the related laboratory exercises intend to provide an insight on advanced joining technologies for polymer-mightweight structures used in engineering applications. A general understanding of the principles of the consolidated and technologies and its main fields of applications is to be accomplished through theoretical and practical lectures.         Theoretical Lectures: <ul> <li>Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in Joining Technology</li> <li>Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics</li> <li>Mechanical Fastening of Polymer-Metal Hybrid Structures</li> <li>Adhesive Bonding of Polymer-Metal Hybrid Structures</li> <li>Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures</li> <li>Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures</li> <li>Joining Processes: Introduction to state-of-the-art joining technologies</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints</li> </ul> <li>Course Outcomes:         <ul> <li>After successful completion of this unit, students should be able to understand the principles of welding and joining of polymer-metal lightweight structures as well as their application fields.</li> <li>J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International</li> <li>J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers</li> <li>D.A. Grewell, A. Benatr, J.B. Park, Plastics and Composites Welding Handbook</li> <li>D. Lohwasser, Z. Chen, Friction Stir</li></ul></li>	Lecturer	Prof. Marcus Rutner			
Contents:           The lecture and the related laboratory exercises intend to provide an insight on advanced joining technologies for polymer-m lightweight structures used in engineering applications. A general understanding of the principles of the consolidated and technologies and its main fields of applications is to be accomplished through theoretical and practical lectures.           Theoretical Lectures: <ul> <li>Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in Joining Technology</li> <li>Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics</li> <li>Mechanical Fastening of Polymer-Metal Hybrid Structures</li> <li>Adhesive Bonding of Polymer-Metal Hybrid Structures</li> <li>Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints</li> </ul> Course Outcomes: <ul> <li>After successful completion of this unit, students should be able to understand the principles of welding and joining of polymer-Metal Hybrid Structures, Wiley, 2018</li> </ul> <ul> <li>S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018</li> <li>J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International</li> <li>J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers</li> <li>D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited<th>Language</th><th>EN</th></li></ul>	Language	EN			
Literature <ul> <li>The lecture and the related laboratory exercises intend to provide an insight on advanced joining technologies for polymer-mellightweight structures used in engineering applications. A general understanding of the principles of the consolidated and technologies and its main fields of applications is to be accomplished through theoretical and practical lectures.         </li> <li>Theoretical Lectures:                 <ul> <li>Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in Joining Technology</li> <li>Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics</li> <li>Mechanical Fastening of Polymer-Metal Hybrid Structures</li> <li>Adhesive Bonding of Polymer-Metal Hybrid Structures</li> <li>Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures</li> <li>Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures</li> <li>Joining Processes: Introduction to state-of-the-art joining technologies</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints</li> <li>Course Outcomes:</li> <li>After successful completion of this unit, students should be able to understand the principles of welding and joining of polymeration fields.</li> <li>S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018</li></ul></li></ul>	Cycle	ViSe			
lightweight structures used in engineering applications. A general understanding of the principles of the consolidated and technologies and its main fields of applications is to be accomplished through theoretical and practical lectures.         Theoretical Lectures: <ul> <li>Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in Joining Technology</li> <li>Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics</li> <li>Mechanical Fastening of Polymer-Metal Hybrid Structures</li> <li>Adhesive Bonding of Polymer-Metal Hybrid Structures</li> <li>Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures</li> <li>Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures</li> <li>Joining Processes: Introduction to state-of-the-art joining technologies</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints</li> <li>Course Outcomes:</li> </ul> <li>After successful completion of this unit, students should be able to understand the principles of welding and joining of polymerimetal lightweight structures as well as their application fields.</li> <li>S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018</li> <li>J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International</li> <li>J. Rotheiser, Joining of Polstics, Handbook for designers and engineers, Hanser Publishers</li> <li>D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook</li> <li>D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited</li>	Content	Contents:			
lightweight structures used in engineering applications. A general understanding of the principles of the consolidated and technologies and its main fields of applications is to be accomplished through theoretical and practical lectures.         Theoretical Lectures: <ul> <li>Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in Joining Technology</li> <li>Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics</li> <li>Mechanical Fastening of Polymer-Metal Hybrid Structures</li> <li>Adhesive Bonding of Polymer-Metal Hybrid Structures</li> <li>Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures</li> <li>Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures</li> <li>Joining Processes: Introduction to state-of-the-art joining technologies</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints</li> <li>Course Outcomes:</li> </ul> <li>After successful completion of this unit, students should be able to understand the principles of welding and joining of polymerimetal lightweight structures as well as their application fields.</li> <li>S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018</li> <li>J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International</li> <li>J. Rotheiser, Joining of Polstics, Handbook for designers and engineers, Hanser Publishers</li> <li>D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook</li> <li>D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited</li>		The lecture and the related laboratory exercises intend to provide an insight on advanced joining technologies for polymer-metr			
Theoretical Lectures:         • Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in Joining Technology         • Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics         • Mechanical Fastening of Polymer-Metal Hybrid Structures         • Adhesive Bonding of Polymer-Metal Hybrid Structures         • Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures         • Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures         Laboratory Exercises:         • Joining Processes: Introduction to state-of-the-art joining technologies         • Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints         Course Outcomes:         After successful completion of this unit, students should be able to understand the principles of welding and joining of polymertel lightweight structures as well as their application fields.         Literature       • S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018         • J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International         • J. Rotheiser, Joining of Pastics, Handbook for designers and engineers, Hanser Publishers         • D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook         • D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited		lightweight structures used in engineering applications. A general understanding of the principles of the consolidated and ne			
Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in joining Technology     Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics     Mechanical Fastening of Polymer-Metal Hybrid Structures     Adhesive Bonding of Polymer-Metal Hybrid Structures     Adhesive Bonding of Polymer-Metal Hybrid Structures     Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures     Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures     Hybrid Joining Processes: Introduction to state-of-the-art joining technologies     Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints     Course Outcomes:     After successful completion of this unit, students should be able to understand the principles of welding and joining of polymetal lightweight structures as well as their application fields.     Literature         S. T. Amancio-Filho, L-A. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018         J., Rotheiser, Joining of Plastics, Handbook for designers, Prentice-Hall International         J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers         D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook         D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited		technologies and its main fields of applications is to be accomplished through theoretical and practical lectures.			
Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in joining Technology     Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics     Mechanical Fastening of Polymer-Metal Hybrid Structures     Adhesive Bonding of Polymer-Metal Hybrid Structures     Adhesive Bonding of Polymer-Metal Hybrid Structures     Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures     Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures     Hybrid Joining Processes: Introduction to state-of-the-art joining technologies     Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints     Course Outcomes:     After successful completion of this unit, students should be able to understand the principles of welding and joining of polymetal lightweight structures as well as their application fields.     Literature         S. T. Amancio-Filho, L-A. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018         J., Rotheiser, Joining of Plastics, Handbook for designers, Prentice-Hall International         J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers         D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook         D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited					
<ul> <li>Introduction to Welding of Lightweight Alloys, Thermoplastics and Fiber Reinforced Plastics</li> <li>Mechanical Fastening of Polymer-Metal Hybrid Structures</li> <li>Adhesive Bonding of Polymer-Metal Hybrid Structures</li> <li>Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures</li> <li>Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures</li> <li>Laboratory Exercises: <ul> <li>joining Processes: Introduction to state-of-the-art joining technologies</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints</li> </ul> </li> <li>Course Outcomes: <ul> <li>After successful completion of this unit, students should be able to understand the principles of welding and joining of polymetal lightweight structures as well as their application fields.</li> </ul> </li> <li>Literature <ul> <li>S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018</li> <li>J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International</li> <li>J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers</li> <li>D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook</li> <li>D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited</li> </ul> </li> </ul>		Theoretical Lectures:			
Mechanical Fastening of Polymer-Metal Hybrid Structures     Adhesive Bonding of Polymer-Metal Hybrid Structures     Adhesive Bonding of Polymer-Metal Hybrid Structures     Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures     Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures     Hybrid Joining Processes: Introduction to state-of-the-art joining technologies     Joining Processes: Introduction to state-of-the-art joining technologies     Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints     Course Outcomes:     After successful completion of this unit, students should be able to understand the principles of welding and joining of polymer metal lightweight structures as well as their application fields.     Itterature         • S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018         J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International         J. J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers         • D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook         • D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited		Review of the relevant properties of Lightweight Alloys, Engineering Plastics and Composites in Joining Technology			
Adhesive Bonding of Polymer-Metal Hybrid Structures     Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures     Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures     Laboratory Exercises:         Joining Processes: Introduction to state-of-the-art joining technologies         Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints     Course Outcomes:     After successful completion of this unit, students should be able to understand the principles of welding and joining of polymetal lightweight structures as well as their application fields.     Literature         S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018         J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International         J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers         D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook         D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited					
<ul> <li>Fusion and Solid State Joining Processes of Polymer-Metal Hybrid Structures         <ul> <li>Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures</li> </ul> </li> <li>Laboratory Exercises:         <ul> <li>Joining Processes: Introduction to state-of-the-art joining technologies</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints</li> </ul> </li> <li>Course Outcomes:         <ul> <li>After successful completion of this unit, students should be able to understand the principles of welding and joining of polymeretal lightweight structures as well as their application fields.</li> </ul> </li> <li>Literature         <ul> <li>S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018</li> <li>J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International</li> <li>J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers</li> <li>D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook</li> <li>D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited</li> </ul> </li> </ul>					
Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures     Laboratory Exercises:         Joining Processes: Introduction to state-of-the-art joining technologies         Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints     Course Outcomes:     After successful completion of this unit, students should be able to understand the principles of welding and joining of polymer metal lightweight structures as well as their application fields.     Literature         S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018         J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International         J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers         D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook         D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited					
Laboratory Exercises: <ul> <li>Joining Processes: Introduction to state-of-the-art joining technologies</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints</li> </ul> Course Outcomes:         After successful completion of this unit, students should be able to understand the principles of welding and joining of polymeretal lightweight structures as well as their application fields.         Literature <ul> <li>S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018</li> <li>J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International</li> <li>J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers</li> <li>D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook</li> <li>D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited</li> </ul>					
<ul> <li>Joining Processes: Introduction to state-of-the-art joining technologies</li> <li>Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints</li> <li>Course Outcomes:</li> <li>After successful completion of this unit, students should be able to understand the principles of welding and joining of polymer-metal lightweight structures as well as their application fields.</li> <li>Literature         <ul> <li>S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018</li> <li>J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International</li> <li>J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers</li> <li>D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook</li> <li>D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited</li> </ul> </li> </ul>		<ul> <li>Hybrid Joining Methods and Direct Assembly of Polymer-Metal Hybrid Structures</li> </ul>			
Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints     Course Outcomes:     After successful completion of this unit, students should be able to understand the principles of welding and joining of polymetal lightweight structures as well as their application fields.     Eiterature     S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018     J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International     J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers     D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook     D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited		Laboratory Exercises:			
Course Outcomes:         After successful completion of this unit, students should be able to understand the principles of welding and joining of polymetal lightweight structures as well as their application fields.         Literature       • S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018         • J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International         • J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers         • D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook         • D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited		Joining Processes: Introduction to state-of-the-art joining technologies			
After successful completion of this unit, students should be able to understand the principles of welding and joining of polyr metal lightweight structures as well as their application fields.         Literature       • S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018         • J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International         • J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers         • D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook         • D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited		Introduction to metallographic specimen preparation, optical microscopy and mechanical testing of polymer-metal joints			
After successful completion of this unit, students should be able to understand the principles of welding and joining of polyr metal lightweight structures as well as their application fields.         Literature       • S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018         • J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International         • J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers         • D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook         • D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited					
Literature <ul> <li>S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018</li> <li>J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International</li> <li>J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers</li> <li>D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook</li> <li>D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited</li> </ul>		Course Outcomes:			
Literature       • S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018         • J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International         • J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers         • D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook         • D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited		After successful completion of this unit, students should be able to understand the principles of welding and joining of polyme			
<ul> <li>S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018</li> <li>J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International</li> <li>J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers</li> <li>D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook</li> <li>D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited</li> </ul>		metal lightweight structures as well as their application fields.			
<ul> <li>S. T. Amancio-Filho, LA. Blaga, Joining of Polymer-Metal Hybrid Structures, Wiley, 2018</li> <li>J.F. Shackelford, Introduction to materials science for engineers, Prentice-Hall International</li> <li>J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers</li> <li>D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook</li> <li>D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited</li> </ul>	Literature				
<ul> <li>J. Rotheiser, Joining of Plastics, Handbook for designers and engineers, Hanser Publishers</li> <li>D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook</li> <li>D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited</li> </ul>					
<ul> <li>D.A. Grewell, A. Benatar, J.B. Park, Plastics and Composites Welding Handbook</li> <li>D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited</li> </ul>					
• D. Lohwasser, Z. Chen, Friction Stir Welding, From basics to applications, Woodhead Publishing Limited					
<ul> <li>J. Friedrich, Metal-Polymer Systems: Interface Design and Chemical Bonding, Wiley, 2017</li> </ul>					
		<ul> <li>J. Friedrich, Metal-Polymer Systems: Interface Design and Chemical Bonding, Wiley, 2017</li> </ul>			

Course L0501: Joining of Poly	urse L0501: Joining of Polymer-Metal Lightweight Structures		
Тур	Practical Course		
Hrs/wk	1		
СР	1		
Workload in Hours	dependent Study Time 16, Study Time in Lecture 14		
Lecturer	f. Marcus Rutner		
Language			
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

	-weight Materials
Typ Hrs/wk	Lecture
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Domonkos Tolnai
Language	
Cycle	Wise Lightweight construction
	- Structural lightweight construction
	- Material lightweight construction
	- Choice criteria for metallic lightweight construction materials
	Steel as lightweight construction materials
	- Introduction to the fundamentals of steels
	- Modern steels for the lightweight construction
	- Fine grain steels
	- High-strength low-alloyed steels
	- Multi-phase steels (dual phase, TRIP)
	- Weldability
	- Applications
	Aluminium alloys:
	Introduction to the fundamentals of aluminium materials
	Alloy systems
	Non age-hardenable Al alloys: Processing and microstructure, mechanical qualities an applications
	Age-hardenable Al alloys: Processing and microstructure, mechanical qualities and applications
	Magnesium alloys
	Introduction to the fundamental of magnesium materials
	Alloy systems
	Magnesium casting alloys, processing, microstructure and qualities
	Magnesium wrought alloys, processing, microstructure and qualities
	Examples of applications
	Titanium alloys
	Introduction to the fundamental of the titanium materials
	Alloy systems
	Processing, microstructure and properties
	rocessing, merostructure and properties

	Exercises and excursions
Literature	George Krauss, Steels: Processing, Structure, and Performance, 978-0-87170-817-5, 2006, 613 S.
	Hans Berns, Werner Theisen, Ferrous Materials: Steel and Cast Iron, 2008. http://dx.doi.org/10.1007/978-3-540-71848-2
	C. W. Wegst, Stahlschlüssel = Key to steel = La Clé des aciers = Chiave dell'acciaio = Liave del acero ISBN/ISSN: 3922599095
	Bruno C., De Cooman / John G. Speer: Fundamentals of Steel Product Physical Metallurgy, 2011, 642 S.
	Harry Chandler, Steel Metallurgy for the Non-Metallurgist 0-87170-652-0 , 2006, 84 S.
	Catrin Kammer, Aluminium Taschenbuch 1, Grundlagen und Werkstoffe, Beuth, 16. Auflage 2009. 784 S., ISBN 978-3-410-22028-2
	Günter Drossel, Susanne Friedrich, Catrin Kammer und Wolfgang Lehnert, Aluminium Taschenbuch 2, Umformung von Aluminium-Werkstoffen, Gießen von Aluminiumteilen, Oberflächenbehandlung von Aluminium, Recycling und Ökologie, Beuth, 16. Auflage 2009. 768 S., ISBN 978-3-410-22029-9
	Catrin Kammer, Aluminium Taschenbuch 3, Weiterverarbeitung und Anwendung, Beuith,17. Auflage 2014. 892 S., ISBN 978-3-410-22311-5
	G. Lütjering, J.C. Williams: Titanium, 2nd ed., Springer, Berlin, Heidelberg, 2007, ISBN 978-3-540- 71397
	Magnesium - Alloys and Technologies, K. U. Kainer (Hrsg.), Wiley-VCH, Weinheim 2003, ISBN 3- 527-30570-x
	Mihriban O. Pekguleryuz, Karl U. Kainer and Ali Kaya "Fundamentals of Magnesium Alloy Metallurgy", Woodhead Publishing Ltd, 2013,ISBN 10: 0857090887

Courses				
Title		Тур	Hrs/wk	СР
Nonlinear Structural Analysis (L027	7)	Lecture	3	4
Nonlinear Structural Analysis (L027	9)	Recitation Section (small)	1	2
Module Responsible	Prof. Alexander Düster			
Admission Requirements	None			
<b>Recommended Previous</b>	Knowledge of partial differential equations is	s recommended.		
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	Students are able to			
	+ give an overview of the different nonlinea	r phenomena in structural mechanics.		
	+ explain the mechanical background of nor			
		al analysis, to identify them in a given situation	and to explain the	eir mathematical a
	mechanical background.			
Skills	Students are able to			
	+ model nonlinear structural problems.			
	+ select for a given nonlinear structural pro	blem a suitable computational procedure.		
	+ apply finite element procedures for nonlin	near structural analysis.		
	+ critically verify and judge results of nonlinear finite elements.			
	+ to transfer their knowledge of nonlinear s	olution procedures to new problems.		
Personal Competence				
	Students are able to			
Social competence	<ul> <li>Students are able to</li> <li>+ solve problems in heterogeneous groups.</li> </ul>			
	+ present and discuss their results in front of others.			
	+ give and accept professional constructive			
	5			
Autonomy	Students are able to			
	+ assess their knowledge by means of exer			
	<ul> <li>+ acquaint themselves with the necessary k</li> <li>+ to transform the acquired knowledge to s</li> </ul>			
Workload in Hours	Independent Study Time 124, Study Time in	Locture 56		
Credit points		Lecture 50		
Course achievement				
	Written exam			
Examination duration and scale	120 min			
	Civil Englisher in a consistentian Characterial	The second s		
Following Curricula	Civil Engineering: Specialisation Structural E Civil Engineering: Specialisation Computation	5 5 1 5		
r onowing curricula		Specialisation II. Civil Engineering: Elective Com	pulsory	
	Materials Science: Specialisation Modeling:		paisory	
	Mechatronics: Technical Complementary Co			
	Mechatronics: Core Qualification: Elective Co			
		tion: Core Qualification: Elective Compulsory		
	Naval Architecture and Ocean Engineering:			
	Ship and Offshore Technology: Core Qualific			
	Theoretical Mechanical Engineering: Special	insting Circulation Taskasland, Elective Compute		

Course L0277: Nonlinear Str	uctural Analysis
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	WiSe
Content	1. Introduction
	2. Nonlinear phenomena
	3. Mathematical preliminaries
	4. Basic equations of continuum mechanics
	5. Spatial discretization with finite elements
	6. Solution of nonlinear systems of equations
	7. Solution of elastoplastic problems
	8. Stability problems
	9. Contact problems
Literature	[1] Alexander Düster, Nonlinear Structrual Analysis, Lecture Notes, Technische Universität Hamburg-Harburg, 2014.
	[2] Peter Wriggers, Nonlinear Finite Element Methods, Springer 2008.
	[3] Peter Wriggers, Nichtlineare Finite-Elemente-Methoden, Springer 2001.
	[4] Javier Bonet and Richard D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge University Press,
	2008.

Course L0279: Nonlinear Structural Analysis	
Тур	Recitation Section (small)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Chemistry of Drinking Water Treatr	nent (L0311)	Lecture	2	1
Chemistry of Drinking Water Treatn	nent (L0312)	Recitation Section (large)	1	2
Water Resource Management (L040		Lecture	2	2
Water Resource Management (L040		Recitation Section (small)	1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous	Knowledge of water management and the	key processes involved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students ha	we reached the following learning results		
Professional Competence				
	water supply. They will understand relevant economic, environmental and social factors. Students will be able to explain a outline the organisational structures of water companies. They will be able to explain the available water treatment processes the scope of their application.			
5K1115	Students will be able to assess complex problems in drinking water production and establish solutions involving was management and technical measures. They will be able to assess the evaluation methods that can be used for this. Students be able to carry out chemical calculations for selected treatment processes and apply generally accepted technical rules a standards to these processes.			
Personal Competence				
Social Competence	Working in a diverse group of specialists,	students will be able to develop and document	complex solutions	for the managem
	and treatment of drinking water. They w	ill be able to take an appropriate professional	position, for examp	ole representing u
	interests. They will be able to develop join	t solutions in teams of diverse experts and prese	nt these solutions t	to others.
Autonomy	Students will be in a position to work on a	subject independently and present on this subje	ct.	
Workload in Hours	Independent Study Time 96, Study Time i	n Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (chemistry) + presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structura	I Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechr	ical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Water an	d Traffic: Compulsory		
	Civil Engineering: Specialisation Coastal E	ngineering: Elective Compulsory		
	International Management and Engineerin	g: Specialisation II. Energy and Environmental Er	ngineering: Elective	Compulsory
	Process Engineering: Specialisation Enviro	nmental Process Engineering: Elective Compulso	ry	
	Process Engineering: Specialisation Proces	ss Engineering: Elective Compulsory		
	Water and Environmental Engineering: Sp	ecialisation Water: Compulsory		
	Water and Environmental Engineering, En	acialization Environment, Elective Compulson,		
	water and Environmental Engineering. Sp	ecialisation Environment: Elective Compulsory		

Course L0311: Chemistry of	Drinking Water Treatment
	Lecture
Hrs/wk	
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Klaus Johannsen
Language	DE
Cycle	WiSe
Content	The topic of this course is water chemistry with respect to drinking water treatment and water distribution
	Major topics are solubility of gases, carbonic acid system and calcium carbonate, blending, softening, redox processes, materials and legal requirements on drinking water treatment. Focus is put on generally accepted rules of technology (DVGW- and DIN- standards). Special emphasis is put on calculations using realistic analysis data (e.g. calculation of pH or calcium carbonate dissolution potential) in exercises. Students can get a feedback and gain extra points for exam by solving problems for homework. Knowledge of drinking water treatment processes is vital for this lecture. Therefore the most important processes are explained coordinated with the course " Water resources management" in the beginning of the semester.
Literature	<ul> <li>MHW (rev. by Crittenden, J. et al.): Water treatment principles and design. John Wiley &amp; Sons, Hoboken, 2005.</li> <li>Stumm, W., Morgan, J.J.: Aquatic chemistry. John Wiley &amp; Sons, New York, 1996.</li> <li>DVGW (Hrsg.): Wasseraufbereitung - Grundlagen und Verfahren. Oldenbourg Industrie Verlag, München, 2004.</li> <li>Jensen, J. N.: A Problem Solving Approach to Aquatic Chemistry. John Wiley &amp; Sons, Inc., New York, 2003.</li> </ul>

Course L0312: Chemistry of Drinking Water Treatment	
Тур	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dr. Klaus Johannsen
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0402: Water Resour	rce Management
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Mathias Ernst
Language	DE
Cycle	WiSe
Content	The lecture provides comprehensive knowledge on interaction of water ressource management and drinking water supply. Content
	<ul> <li>overview:</li> <li>Current situation of global water resources</li> <li>User and Stakeholder conflicts</li> <li>Wasserressourcenmanagement in urbane Gebieten</li> <li>Rechtliche Aspekte, Organisationsformen Trinkwasserversorgungsunternehmen.</li> <li>Ökobilanzierung, Benchmarking in der Wasserversorgung</li> </ul>
Literature	<ul> <li>Aktuelle UN World Water Development Reports</li> <li>Branchenbild der deutschen Wasserwirtschaft, VKU (2011)</li> <li>Aktuelle Artikel wissenschaftlicher Zeitschriften</li> <li>Ppt der Vorlesung</li> </ul>

Course L0403: Water Resour	ourse L0403: Water Resource Management		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Mathias Ernst		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
	-		11	
Title Integrated Transportation Planning	g (L1068) Typ Project-/problem-based	Learning	Hrs/wk 4	<b>CP</b> 6
Module Responsible		Learning	-	0
Admission Requirements				
Recommended Previous		anchort B	lanning and T	roffic Engineerin
Keconniended Previous		ansport P	lanning and 1	ranic Engineerin
	After taking part successfully, students have reached the following learning results			
Professional Competence				
	Students are able to:			
ranomedge				
	describe interdependencies between land-use/location choice and transportation			
	explain and evaluate the social, ecological and economic effects of transport and			res.
	<ul> <li>relate current issues in the area of integrated transport planning and formulate a</li> </ul>	in opinion	on them.	
Skills	Students are able to:			
	• quantify important parameters, which influence travel demand or are influenced			
	<ul> <li>comprehensively examine a pre-defined or self-selected topic from a transporta results in accordance with scientific conventions.</li> </ul>	tion studi	es perspectiv	e and document t
Personal Competence				
Social Competence	Students are able to:			
	<ul> <li>provide feedback on topical contents and their teaching.</li> </ul>			
	constructively handle feedback on their own work.			
	<ul> <li>produce results in group work and document these.</li> </ul>			
Autonomy	Students are able to:			
	assess potential consequences of their future professional activities			
	<ul> <li>independently plan working on a pre-defined project topic, acquire the necessary</li> </ul>	v knowled	lae and use a	opropriate means
	its execution.	y knowiec	ige and use a	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	written assignment with presentation during the semester			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Water and Traffic: Compulsory			
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective	Compuls	ory	
	Water and Environmental Engineering: Specialisation Cities: Compulsory			

Course L1068: Integrated Tr	ansportation Planning
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß
Language	DE
Cycle	WiSe
	The course will provide students with an understanding of interdependencies between land-use and transportation. Specific topics include a.o.:    interactions between transport and the environment and consequent limitations  characteristics of integrated planning  complex planning processes  interdependencies of location choice and mobility behaviour  transport and land-use policies  project on current issues in transportation studies
Literature	Kutter, Eckhard (2019) Stadtstruktur und Erreichbarkeit in der postfossilen Zukunft. Erich Schmidt Verlag. Berlin. Gies, Huber u. a. (Hrsg.) (93. Ergänzung 2022) Handbuch der kommunalen Verkehrsplanung. Herbert Wichmann Verlag. Berlin, Offenbach. (Loseblattsammlung mit kontinuierlichen Ergänzungen)

Courses					
Гitle			Тур	Hrs/wk	СР
Applied Tunnel Constructions (L24	)7)		Lecture	2	3
ntroduction to tunnel construction	(L0707)		Lecture	1	2
Introduction to tunnel construction	(L1811)		Recitation Section (large)	1	1
Module Responsible	Prof. Jürgen Grabe				
Admission Requirements	None				
<b>Recommended Previous</b>	Modules from Bachelor	studies Civil and environr	nental engineering:		
Knowledge	Geotechnics I-II				
Educational Objectives	After taking part succes	ssfully, students have read	ched the following learning results		
Professional Competence					
Knowledge	Knowledge of different tunnel construction types as well as special methods and techniques of subsoil construction.				
Skills	Basic knowledge of tun	nnel design as well as prac	tical skills in structural tunnel analysis.		
Personal Competence					
Social Competence	Capacity for teamwork concerning project management and design of tunnels.				
Autonomy	Promotion of independent and creative work flow in the framework of a design exercise.				
Workload in Hours	Independent Study Tim	ne 124, Study Time in Lect	ure 56		
Credit points	6				
Course achievement	Compulsory Bonus	Form	Description		
	No 5 %	Excercises			
Examination	Written exam				
Examination duration and	120 minutes				
scale					
Assignment for the	Civil Engineering: Spec	ialisation Structural Engine	eering: Elective Compulsory		
Following Curricula	Civil Engineering: Spec	ialisation Geotechnical En	gineering: Compulsory		
	Civil Engineering: Speci	ialisation Coastal Enginee	ring: Compulsory		
	Civil Engineering: Speci	ialisation Water and Traffi	c: Elective Compulsory		
	Civil Engineering: Spec	ialisation Computational E	ngineering: Elective Compulsory		

Course L2407: Applied Tunnel Constructions	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe, Tim Babendererde
Language	DE
Cycle	WiSe
Content	
Literature	

Course L0707: Introduction t	o tunnel construction		
Тур	Lecture		
Hrs/wk			
CP	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Dr. Julian Bubel		
Language	DE		
Cycle	WiSe		
Content	<ul> <li>Definitions</li> <li>Historical development in tunneling</li> <li>Geology for tunneling</li> <li>Hard rock tunneling (construction composite and machines)</li> <li>Tunnelung in temporarly stable soil with conventional construction methods</li> <li>Tunneling in soft soils (form of supports, shield types, compressed air application)</li> <li>Pipe jacking</li> <li>Tunnel Lining, tunnel supporting structures</li> <li>Calculation approaches for supporting structures in shield-driven tunnels</li> <li>Surveying for tunneling</li> <li>Safety requirements</li> <li>Construction Contract</li> <li>Literature and sources</li> </ul>		
Literature	Vorlesung/Übung s. www.tu-harburg.de/gbt		

Course L1811: Introduction to tunnel construction	
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Julian Bubel
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Fitle Module Responsible Admission Requirements		-		Courses				
-		Тур	Hrs/wk	СР				
Admission Requirements	Dozenten des SD B							
	None							
<b>Recommended Previous</b>	Subjects of the Structural Engineering s	pecialisation.						
Knowledge								
Educational Objectives	After taking part successfully, students	have reached the following learning results						
<b>Professional Competence</b>								
Knowledge		their detailed knowledge in the field of struc pplication and discuss critically in the contex						
	The students can develop solving strategies and approaches for fundamental and practical problems in structural and construction engineering. They may apply theory based procedures and integrate safety-related, ecological, ethical, and economic view poin of science and society.							
	Scientific work techniques that are used	can be described and critically reviewed.						
Skills	The students are able to independently select methods for the project work and to justify this choice. They can explain how the methods relate to the field of work and how the context of application has to be adjusted. General findings and furth developments may essentially be outlined.							
Personal Competence								
Social Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems f the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to the colleagues.							
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the giv deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedba from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology							
Workload in Hours	Independent Study Time 180, Study Tim	ne in Lecture 0						
Credit points	6							
Course achievement	None							
Examination	Study work							
Examination duration and	see FSPO							
scale								

## Module M0969: Selected Topics in Civil Engineering

Courses				
Title		Тур	Hrs/wk	СР
Design of Composite Bridges (L3092)		Integrated Lecture	2	3
Analysis of Offshore Structures (L1867)		Lecture	1	1
Energy Geotechnics (L3227)		Lecture	3	3
Solid Matter Process Technology fo	r Biomass (L0052)	Lecture	2	3
Forum I - Geotechnics and Constru	ction Management (L1634)	Seminar	1	1
Forum II - Geotechnics and Constru	ction Management (L1635)	Seminar	1	1
Timber Structures (L1151)		Seminar	2	2
Innovative Timber Construction (L2	666)	Lecture	2	4
Glass Structures (L1152)		Lecture	2	2
Glass Structures (L1447)		Recitation Section (large)	1	1
Sustainable landfill design and ope	ration (L3270)	Integrated Lecture	3	3
Special Topics in Steel Design (L30	91)	Integrated Lecture	2	3
Special topics of civil engineering 1	CP (L2378)		1	1
Special topics of civil engineering 2	2 LP (L2379)		2	2
Special topics of civil engineering 3	3 LP (L2380)		3	3
Structural Design (L2789)		Seminar	2	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
	<ul> <li>Students are able to find their way through sel</li> </ul>			
	<ul> <li>Students are able to explain basic models and</li> </ul>	l procedures in selected special areas of	civil and structure	al engineering.
	<ul> <li>Students are able to interrelate scientific and t</li> </ul>	technical knowledge.		
Skills	• Students are able to apply basic methods in selected areas of civil and structural engineering.			
Personal Competence				
Social Competence				
Autonomy				
hateneny	<ul> <li>Students can chose independently, in which f courses.</li> </ul>	fields they want to deepen their knowled	dge and skills th	ough the election o
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the	Civil Engineering: Specialisation Structural Engineerir	ng: Elective Compulsory		
Following Curricula				
_	Civil Engineering: Specialisation Coastal Engineering:			
	Civil Engineering: Specialisation Water and Traffic: El			
	Civil Engineering: Specialisation Computational Engin	ieening. Elective Compulsory		

Course L3092: Design of Composite Bridges	
Тур	Integrated Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	
Literature	

Тур	Lecture
Hrs/wk	
CP	
Examination Form	
Examination duration and	30 min
scale	
Lecturer	Dr. Said Fawad Mohammadi
Language	DE/EN
Cycle	SoSe
Content	Topic 1: Types of Offshore Structures, Fixed and floating structures for Oil & Gas and Offshore Wind industry
	Topic 2: Wave Forces, Morisons equation
	Topic 3: Irregular Seastates, Power spectrum and application of FFT
	Topic 4: Additional Environmental Forces, wind spectra, current forces
	Topic 5: Linear-Time-Invariant Systems, response of an LTI-system in frequency domain
	Topic 6: Tubular Welded Connections, stress concentration factors, weld geometry
	Topic 7: Introduction to Fracture Mechanics, criteria for fracture initiation and crack growth
	Topic 8: Time and Frequency Domain Fatigue Analyses, rainflow counting, application of LTI-systems for frequency domain fatigu
	Topic 9: Offshore Installation and Exam, installation of structures, pile driving, pipe laying techniques
Literature	Chakrabarti, Handbook of Offshore Engineering, 2005
	Sarpkaya, Wave Forces on Offshore Structures, 2010
	Faltinsen, Sea Loads on Ships and Offshore Structures, 1998
	Sorensen, Basic Coastal Engineering, 2006
	Dowling, Mechanical Behavior of Materials, 2007
	Haibach, Betriebsfestigkeit, 2006
	Marshall, Design of Welded Tubular Connections, 1992
	Newland, Random vibrations, spectral and wavelet analysis, 1993

Course L3227: Energy Geotechnics		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Schriftliche Ausarbeitung (laut FPrO)	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Pauline Kaminski	
Language	DE/EN	
Cycle	WiSe	
	Energy geotechnics is a young field in geotechnical engineering with the aim of developing sustainable geotechnical solutions for future-oriented issues relating to the production, transport, operation, decommissioning, and waste utilisation of various energy sources. Examples of possible fields of activity in energy geotechnics include geothermal energy and thermally activated foundation components, foundations for onshore and offshore wind turbines, the decommissioning of mining facilities and the handling of waste products from fossil fuels such as tailings and the geological storage of CO2. Relevant soil mechanical processes in these applications include the thermo-hydro-mechanically coupled behaviour of soils, multiphase flow in porous media and partially saturated soils. The lecture gives an overview of various aspects of energy geotechnics and provides in-depth knowledge of the associated soil mechanical processes. In addition, CO2-scarce geotechnical applications are discussed and emission estimates as well as the optimisation of geotechnical structures according to sustainability aspects are addressed.	
Literature		

Course L0052: Solid Matter F	Process Technology for Biomass
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Prof. Werner Sitzmann
Language	DE
Cycle	SoSe
Content	The industrial application of unit operations as part of process engineering is explained by actual examples of solid biomass
	processes. Size reduction, transportation and dosing, drying and agglomeration of renewable resources are described as important
	unit operations when producing solid fuels and bioethanol, producing and refining edible oils, when making Btl - and WPC -
	products. Aspects of explosion protection and plant design complete the lecture.
Literature	Kaltschmitt M., Hartmann H. (Hrsg.): Energie aus Bioamsse, Springer Verlag, 2001, ISBN 3-540-64853-4
	Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz, Schriftenreihe Nachwachsende Rohstoffe,
	Fachagentur Nachwachsende Rohstoffe e.V. www.nachwachsende-rohstoffe.de
	Bockisch M.: Nahrungsfette und -öle, Ulmer Verlag, 1993, ISBN 380000158175

Course L1634: Forum I - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1635: Forum II - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1151: Timber Structures	
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and	90 min
scale	
Lecturer	Prof. Torsten Faber
Language	DE
Cycle	WiSe
Content	
Literature	

Course L2666: Innovative Timber Construction	
	Lecture
Hrs/wk	
	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and	45 Minuten
scale	
Lecturer	Dr. Andreas Meisel
Language	DE
Cycle	WiSe
Content	
Literature	- Blass, J.: "Ingenieurholzbau"
	- Schickhofer, G.: "BSPhandbuch: Holz-Massivbauweise in Brettsperrholz"
	- Informationsdienst Holz: div. Merkblätter und Broschüren
	- Wallner-Novak M.: Brettsperrholz Bemessung, Band 1 und 2
	- Gerner M.: "Fachwerk: Entwicklung, Instandsetzung, Neubau"
	- Meisel, A.: "Historische Dachwerke: Beurteilung, realitätsnahe statische Analyse und Instandsetzung"
	- Kempe K.: "Dokumentation Holzschädlinge"
	- Huckfeldt T.: "Hausfäule- und Bauholzpilze"

Course L1152: Glass Structures		
Тур	Lecture	
Hrs/wk		
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and		
scale		
Lecturer	Marvin Matzik	
Language	DE	
Cycle	WiSe	
Content	Glass structures	
	<ul> <li>Introduction of the material glass (production, refinement, material characteristic)</li> <li>design of facades</li> </ul>	
	- facade types	
	- static calculation of glazing	
	- static calculation of facades	
	- load bearing behavior of glazing (plate or membrane stiffness)	
	- vertical / horizontal glazing with safety-related requirements	
	- glass structures	
	- fire safety of glass facades	
	- construction physics of facades and glazing	
Literature		

Course L1447: Glass Structures	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L3270: Sustainable la	andfill design and operation
Тур	Integrated Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Dr. Marco Ritzkowski
Language	EN
Cycle	SoSe
Content	The course introduces the development of modern waste resource management and demonstrates the importance of landfills in the context of recycling processes. Based on international (EU) and national legislation, the current landfill situation is presented and the future significance of landfills will be discussed. A central element of the course deals with the main transformation processes in the landfilled waste, the emission of gases and leachate, the long-term behaviour of landfills as well as aftercare and after-utilisation measures. Further focal points of the course are measures for the sustainable reduction of environmentally and climate-damaging emissions and aspects of landfill technology in an international context.
Literature	<ol> <li>Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105, Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305</li> <li>Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332</li> <li>Solid Waste Landfilling - Concepts, Processes, Technologies. Cossu, R. and Stegmann, R. (Eds.), ISBN: 978-0-12-818336-6</li> <li>PDF (Volltext) über TUB</li> </ol>

Course L3091: Special Topics in Steel Design	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner, Nikolay Lalkovski
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2378: Special topics of civil engineering 1CP		
Тур		
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Examination Form	Fachtheoretisch-fachpraktische Arbeit	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Dozenten des SD B	
Language	DE	
Cycle	WiSe/SoSe	
Content	The course occurs only if required. The content is defined at short notice.	
Literature	Die Literatur wird kurzfristig festgelegt.	

Course L2379: Special topics of civil engineering 2 LP		
Тур		
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Fachtheoretisch-fachpraktische Arbeit	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Dozenten des SD B	
Language	DE	
Cycle	WiSe/SoSe	
Content	The course occurs only if required. The content is defined at short notice.	
Literature	Die Literatur wird kurzfristig festgelegt.	

Course L2380: Special topics of civil engineering 3 LP	
Тур	
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2789: Structural Design		
Тур	Seminar	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	20 min	
scale		
Lecturer	Dr. Jan Mittelstädt	
Language	DE/EN	
Cycle	SoSe	
Content		
Literature	[1] Structure Systems by Heino Engel, Hantje Cantz, 3rd edition (Feb 2007), ISBN-10: 3775718761	
	Form and Force, Designing Efficient, Expressive Structures by Allan, E., Zalewski, W. et al, John Wiley and	
	Sons; 1st edition (Sept 2009), ISBN-10: 047017465X	
	[2] Peter Rice: An Engineer Imagines, ISBN-10 : 1849944237	
	[3] Konrad Wachsmann and the Grapevine Structure by C. Sumi et al., Park Books (Oct 2018), ISBN-10:	
	9783038601104	
	[4] Manual of Multi-Story Timber Construction by Hermann Kaufmann, Stefan Krotsch, Stefan Winter, DETAIL,	
	(June 2018), ISBN-10: 3955533948	
	[5] The Art of Structural Design: A Swiss Legacy by B. Billington, Princeton University Art Museum; First Edition	
	edition (Mar 2003), ISBN-10: 0300097867	
	[6] Structured Lineages: Learning from Japanese Structural Design by G. Nordenson et al, The Museum of	
	Modern Art (Jul 2019), ISBN-10: 1633450562	
	[7] The Structure: Works of Mahendra Raj by V. Mehta, R. Mehndiretta, A. Huber, Park Books (Oct 2015),	
	ISBN-10: 3038600253	

	Hrs/wk	СР
lem-based Learning	g 4	6
esults		
eds for action in measures n approaches, me	ethods, numeri	cal models, plannir
subsequent discus	sion. The work	on the complex ta
ory e Compulsory sory		
e Co sory	/ ipulsory	pulsory

Course L2926: Sustainable N	ature-based Coastal Protection in a Changing Climate (SeaPiaC)
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Peter Fröhle
Language	EN
Cycle	WiSe
Content	<ul> <li>Climate and Climate Change</li> <li>General Impacts of Climate Change on Wind Regime and Water Cycle</li> <li>Consequences of Climate Change for Coastal Processes</li> <li>Coastal Protection in Taiwan and Germany</li> <li>Fundamentals of Climate Adaptation</li> <li>Nature-Based Solutions (NBS) for Coastal Protection</li> </ul>
Literature	<ul> <li>Materials provided on eLearning Platform (HOOU Platform)</li> <li>Depending on the main topics of the course in the respective year, the literature ( recent papers) will be provided in the course-material or via StudIP.</li> </ul>

Courses	
<b>Title</b> Adaptation to climate change in hy	Typ     Hrs/wk     CP       draulic engineering (L2291)     Project-/problem-based Learning     4     6
Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	Hydrology Hydraulic Engineering
Educational Obiectives	After taking part successfully, students have reached the following learning results
Professional Competence Knowledge Skills	<ul> <li>Climate protection and climate adaptation</li> <li>Insights into climate change and its regional characteristics - fundamentals, climate modelling / climate models</li> <li>Impacts of climate change on the components of the regional hydrological cycle</li> <li>Fundamentals of analysis of climate data</li> <li>Consequences of the impact of the climate change</li> <li>Measures for climate adaptation</li> <li>Assessment, prioritization and communication of adaptation measures</li> <li>Fundamentals of the analysis of hydrometeorological and hydrological data</li> </ul>
Personal Competence Social Competence Autonomy	<ul> <li>Working in heterogenous groups</li> <li>Working with different scientific / non-scientific disciplines</li> <li>Self reflection</li> </ul>
	Autonomous work on complex tasks
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	
Examination	
Examination duration and scale	Preparation of a written report and a presentation of a complex task.
•	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory

Course L2291: Adaptation to	climate change in hydraulic engineering	
Тур	Project-/problem-based Learning	
Hrs/wk	l .	
СР	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Peter Fröhle	
Language	DE	
Cycle	WiSe	
Content	<ul> <li>Climate protection and climate adaptation</li> <li>Findings on climate change and its regional characteristics: fundamentals of climate change, climate modelling / climate models</li> <li>Impacts of climate change on the components of the regional hydrological cycle(climate science view)</li> <li>Fundamentals of the analysis of climate data</li> <li>Concequences of the impacts of climate change (ingenieering science view)</li> <li>Measures for climate change adaptation</li> <li>Assessment, prioritization and communication of measures</li> <li>Fundamentals of analysis of hydrometeorological and hydrological data</li> </ul>	
Literature	<ul> <li>Wird bereitgestellt über die HOOU - eLearning Plattform</li> <li>abhängig von den jeweils schwerpunktmäßig behandelten Fragestellungen wird das Schrifttum (aktuelle Paper) in der Veranstaltung bzw. über StudIP zur Verfügung gestellt.</li> </ul>	

House Higher House	rn discretization methods in stru			
Courses				
Title		Тур	Hrs/wk	СР
Modern discretization methods in s	tructural mechanics (L3043)	Lecture	2	3
Modern discretization methods in s	tructural mechanics (L3044)	Recitation Section (small)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	<ul><li>Finite Element Methods</li><li>Flächentragwerke</li></ul>			
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, students can express the basic aspects of modern discretization methods in structura mechanics.			
Skills	After successful completion of this module, the students will be able to use and further improve modern discretization methods for problems in structural mechanics.			
Personal Competence				
Social Competence	Students can			
	<ul> <li>participate in subject-specific and interdis</li> </ul>	sciplinary discussions.		
	<ul> <li>defend their own work results in front of other</li> </ul>			
	<ul> <li>promote the scientific development of co</li> </ul>	lleagues		
	Furthermore, they can give and accept pr	ofessional constructive criticism		
Δυτοροπγ	Students are able to gain knowledge of the sub	ect area from given and other sources and ar	only it to new pro	blems Furthermo
, according	they are able to structure the solution process f			
Workload in Hours	Independent Study Time 124, Study Time in Leo	ture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Enginee	ering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical En	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Engin	neering: Elective Compulsory		
	Civil Engineering: Specialisation Computational	Engineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisat	on Simulation Technology: Elective Compulso	ry	

Тур	Lecture
Hrs/wk	
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	EN
Cycle	WiSe
Content	<ul> <li>The course covers variational formulations, various locking phenomena and alternative formulations for finite elements an modern discretization schemes in the context of structural mechanics, like isogeometric analysis.</li> <li>variational formulation of finite elements, mixed variational principles</li> <li>geometrical and material locking effects in structural and solid mechanics</li> <li>hybrid-mixed and enhanced assumed strain finite element formulations, reduced integration and stabilization, DSG method u-p formulations</li> <li>patch test, stability, convergence</li> <li>linear and non-linear analyses</li> <li>introduction to isogeometric analysis</li> <li>isogeometric beam, plate and shell formulations</li> <li>locking effects and their avoidance in modern, smooth discretization schemes, like isogeometric analysis</li> </ul>
Literature	<ul> <li>lecture notes and selected scientific papers</li> <li>O.C. Zienkiewicz, R.L. Taylor, and J.Z. Zhu: Finite Element Method: Its Basis and Fundamentals. Elsevier, 2013.</li> <li>J. Austin Cottrell, Thomas J. R Hughes, Yuri Bazilevs: Isogeometric Analysis: Toward Integration of CAD and FEA. Wiley, 2009</li> </ul>

Course L3044: Modern discre	ourse L3044: Modern discretization methods in structural mechanics		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Scientific Working in Computationa	Engineering (L2764)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge in scientific writing. String interest in topic	s related to computing in civil engine	ering.	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the for	ollowing learning results		
Professional Competence				
Personal Competence	course instructors and in collaboration with each other, the students will also learn to understand the complex process of scientific thinking, being able to accurately plan, implement and analyze scientific projects, such as prospective master theses. A project will be conducted throughout the semester, which will contribute to the grade. Since scientific writing is of particular importance in this course, a scientific paper will be developed based, which is a prerequisite for the final examination. The paper will be written based on the project conducted within this course. Project meetings in small groups, presentations, and critical discussions of scientific publications are further key activities. The students will be capable (i) of solving a scientific problem following a scientific methodology, (ii) of documenting their work effectively in the form of a paper, and (iii) of sharing their work in a presentation.			
Autonomy	The students will be able to extend their knowledge and apply it to solve scientific problems by working independently in a project			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	10 pages of work with 15-minute oral presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective	Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering:	Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elect	ve Compulsory		
	Civil Engineering: Specialisation Structural Engineering: Ele	ctive Compulsory		
	Civil Engineering: Specialisation Computational Engineering	: Elective Compulsory		
	Computer Science: Specialisation II: Intelligence Engineerin	g: Elective Compulsory		

Course L2764: Scientific Wor	rking in Computational Engineering
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	WiSe/SoSe
Content	In the course, a scientific problem of practical relevance will first be defined, taking into account the interests of the students participating in the course. The scientific problem will then systematically be solved within the framework of a comprehensive project. The principles of scientific working will be taught based on the scientific problem defined previously. As an integral part of scientific working, fundamentals of scientific writing will be presented and applied to a scientific paper to be written during the course. Topics related to scientific writing include structuring in scientific writing (structuring the abstract, the introduction, the main part, the summary and conclusions, and the acknowledgments and references) and recommendations on effective scientific writing (principles of composition, use of English in scientific writing, useful tips, creating figures, writing in mathematics, referencing, and formal email correspondence). A final paper and a final presentation will be assembled by the students.
Literature	Smarsly, K. & Dragos, K., 2019. Scientific Writing in Engineering. Tredition, Hamburg, Germany.

Module M1956: Build	ing and Excavation Law			
Courses				
Title		Тур	Hrs/wk	СР
Construction law BGB and VOB - la	w in (excavation) practice (L3182)	Lecture	2	3
Construction disputes from constru	ction (excavation) practice (L3181)	Lecture	2	3
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
<b>Recommended Previous</b>	Complete modules: Geotechnics I-III			
Knowledge				
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	Students will gain knowledge of			
	<ul> <li>the history of civil engineering law,</li> </ul>			
	<ul> <li>basics of foundation and civil engineering</li> </ul>	ng law,		
	<ul> <li>legal aspects of technical regulations in</li> </ul>	civil engineering (with case studies),		
	<ul> <li>the civil engineering contract,</li> </ul>			
	<ul> <li>the liability of the designer and contract</li> </ul>	tor in civil engineering,		
	<ul> <li>the subsoil risk and the system risk,</li> </ul>			
	<ul> <li>the total debt in (civil) engineering law,</li> </ul>			
	<ul> <li>the (construction) conflict, dispute avoidance models and the construction process,</li> <li>the systematics of construction contract law,</li> <li>the BGB construction contract law,</li> </ul>			
	<ul> <li>responsibilities on the construction site</li> </ul>			
	<ul> <li>remuneration and contract management</li> </ul>	1,		
	<ul> <li>liability for defects,</li> <li>public procurement law</li> </ul>			
	<ul><li> public procurement law</li><li> Disturbed construction processes: How</li></ul>	much monoy am Lontitlad to?		
	<ul> <li>Correct calculation of supplements.</li> </ul>	much money and entitled to?		
	• concerculation of supplements.			
Skills	Students learn to apply legal aspects in planr	ing and construction in a legally balance	d way. Students learn l	now to use legal a
	construction management aspects in practice	(planning and construction) on the cons	struction site in a target	ted manner and h
	to manage the construction project optimally.			
Personal Competence				
Social Competence	Students can work in groups and support each	n other in finding solutions.		
Autonomy	Students are able to assess their own strength	ns and weaknesses and organize their tim	e and learning manage	ment based on th
Workload in Hours		ecture 56		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engin	eering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Eng	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Tra	affic: Elective Compulsory		
	Civil Engineering: Specialisation Computationa	al Engineering: Elective Compulsory		

Course L3182: Construction law BGB and VOB - law in (excavation) practice	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Günther Schalk
Language	DE
Cycle	WiSe
Content	
Literature	Literatur:
	- Folienskript (in der Vorlesung erhältlich)
	- Fuchs/Maurer/Schalk: Handbuch Tiefbaurecht

Course L3181: Construction	urse L3181: Construction disputes from construction (excavation) practice		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Ingo Junker		
Language	DE		
Cycle	WiSe		
Content			
Literature			

C					
Courses					
Title		Тур	Hrs/wk	СР	
Coastal- and Flood Protection (L08) Coastal- and Flood Protection (L14)	-	Lecture	2 1	3 1	
Maintenance and Defence of Flood	-	Project-/problem-based Learning Lecture	2	2	
Module Responsible					
Admission Requirements					
Recommended Previous					
Knowledge					
Educational Objectives	After taking part successfully, students have reached the	following learning results			
Professional Competence					
Knowledge	The students have the capability to define and explain in	n detail the important aspects of erosi	on protection	and flood protecti	
and are able to apply the aspects to practical coastal protection problems. They are able t			design and	dimension importa	
	coastal protection measures from the functional and from the constructional point of view.				
CL 111					
SKIIIS	The students are able to select design approaches for the functional and constructional design of erosion and flood protection				
	measures and apply these approaches to practical design	Lasks.			
Personal Competence					
Social Competence	The students are able to deploy their gained knowledge	e in applied problems such as the fun	ctional and co	onstructive design	
	coastal and flood protection structures. Additionaly, they	will be able to work in team with engine	eers of other d	lisciplines.	
Autonomy	The students will be able to independently extend their ki	nowledge and apply it to new problems			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70				
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	The duration of the examination is 130 min. The exami	nation includes tasks with respect to	the general ι	understanding of t	
scale	lecture contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Con	npulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	: Elective Compulsory			
	Civil Engineering: Specialisation Structural Engineering: E	lective Compulsory			
	Environmental Engineering: Specialisation Environment a	nd Climate: Elective Compulsory			
	Environmental Engineering: Specialisation Water Quality a	and Water Engineering: Elective Compu	Ilsory		
	Water and Environmental Engineering: Specialisation Env	ironment: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Wat	er: Elective Compulson			

Course L0808: Coastal- and F	lood Protection
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	EN
Cycle	WiSe
Content	Protection of sandy coasts
	<ul> <li>Sediment transport</li> <li>Morphology</li> <li>Technical solution for the protection of sandy coasts <ul> <li>Construction in direction of the coast</li> <li>Constructions perpendicular to the coast</li> <li>Other Concepst</li> </ul> </li> <li>Calculation approaches and numerical models</li> </ul> Flood Protection <ul> <li>Classification of constructions / measures</li> <li>Dikes</li> <li>Dunes</li> <li>Foreland - constructions</li> <li>Flood-Protection Walls</li> </ul>
	Drainage of the hinterland Vorlesungsumdruck Coastal Engineering Manual CEM

Course L1415: Coastal- and I	urse L1415: Coastal- and Flood Protection	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Peter Fröhle	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1411: Maintenance	and Defence of Flood Protection Structures
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Olaf Müller
Language	EN
Cycle	WiSe
Content	<ul> <li>Dike protection</li> <li>Maintennance of flood protection measures</li> </ul>
Literature	Vorlesungsumdruck

6				
Courses				
Title	(1.0000)	Тур	Hrs/wk	СР
Waste and Environmental Chemist Biological Waste Treatment (L0318		Practical Course Project-/problem-based Learning	2 3	2 4
		Project-problem-based Learning	5	4
Module Responsible				
Admission Requirements				
	chemical and biological basics			
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	e The module aims possess knowledge concerning the planning of biological waste treatment plants. Students are able to design and layout of anaerobic and aerobic waste treatment plants in detail, describe different techniques for waste gas			
	plants for biological waste treatment plants	and explain different methods for waste analytics.		
Skills		ation of design and layout of plants. They can critical	-	
		cherché and evaluate literature and date connected of reflecting and evaluating findings in the group.	to the tasks	given in der moo
Personal Competence				
	Students can participate in subject-specific	and interdisciplinary discussions, develop cooperate	ed solutions a	nd defend their (
···· ,		e the scientific development in front of colleagues.		
	accept professional constructive criticism.			
Autonomy	Students can independently tan knowledge	from literature, business or test reports and transfo	rm it to the c	ourse projects. T
hatohomy		s as well as in the interim presentation, to assess the		
	steps on this basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance with th			
	potential social, economic and cultural impa			
Workload in Hours	Independent Study Time 110, Study Time in	Lecture 70		
Credit points	6			
Course achievement	Compulsory Bonus Form	Description		
	Yes None Subject theoretica	l and		
	practical work			
Examination	Presentation			
Examination duration and scale	Elaboration and Presentation (15-25 minute	s in groups)		
Assignment for the	Civil Engineering: Specialisation Coastal Eng	ineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnic	al Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural E	ingineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and	Traffic: Elective Compulsory		
	Bioprocess Engineering: Specialisation A - G	eneral Bioprocess Engineering: Elective Compulsory		
	Chemical and Bioprocess Engineering: Spec	ialisation General Process Engineering: Elective Comp	oulsory	
	Chemical and Bioprocess Engineering: Spec	ialisation Bioprocess Engineering: Elective Compulsor	у	
	Chemical and Bioprocess Engineering: Spec	ialisation Chemical Process Engineering: Elective Con	npulsory	
	Environmental Engineering: Core Qualificati	on: Compulsory		
	International Management and Engineering:	Specialisation II. Renewable Energy: Elective Compu	lsory	
		mental Process Engineering: Elective Compulsory		
	Water and Environmental Engineering: Spec	ialisation Cities: Elective Compulsory		
		ialisation Environment: Elective Compulsory		

Course L0328: Waste and En	vironmental Chemistry
Тур	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	The participants are divided into groups. Each group prepares a transcript on the experiment performed, which is then used as basis for discussing the results and to evaluate the performance of the group and the individual student. In some experiments the test procedure and the results are presented in seminar form, accompanied by discussion and results evaluation. Experiments ar e.g. Screening and particle size determination Fos/Tac AAS Chalorific value
Literature	Scripte

Course L0318: Biological Wa	ourse L0318: Biological Waste Treatment	
Тур	Project-/problem-based Learning	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Kerstin Kuchta	
Language	EN	
Cycle	WiSe	
Content	<ol> <li>Introduction</li> <li>biological basics</li> <li>determination process specific material characterization</li> <li>aerobic degradation ( Composting, stabilization)</li> <li>anaerobic degradation (Biogas production, fermentation)</li> <li>Technical layout and process design</li> <li>Flue gas treatment</li> <li>Plant design practical phase</li> </ol>	
Literature		

Module M2025: Finite	element modeling of structur	es		
Courses				
Title		Тур	Hrs/wk	СР
Finite element modeling of structur	es (L3046)	Lecture	2	3
Finite element modeling of structur	es (L3047)	Recitation Section (small)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	<ul><li>Finite Element Methods</li><li>Thin-walled structures</li></ul>			
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, students can express the basic aspects of modelling of structures with finite element			
Skills	After successful completion of this module, the students will be able to model structures with finite elements and to analy structures using appropriate computational methods.			
Personal Competence				
Social Competence	Students can			
	participate in subject-specific and interdisciplinary discussions,			
	<ul> <li>defend their own work results in front of others</li> <li>promote the scientific development of colleagues</li> </ul>			
	• Furthermore, they can give and accept	t professional constructive criticism		
Autonomy	Students are able to gain knowledge of the subject area from given and other sources and apply it to new problems. Furthermore they are able to structure the solution process for problems in the area of finite element modelling of structures.			
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	written elaboration of a project work (10-15	pages)		
scale				
Assignment for the	Civil Engineering: Specialisation Computation	nal Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal Eng	ineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotechnica	al Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural E	ngineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Speciali	sation Simulation Technology: Elective Compulso	rv	

Course L3046: Finite elemen	t modeling of structures
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	EN
Cycle	WiSe
Content	<ul> <li>Basic phenomena and aspects of the finite element modelling of structures are discussed. Besides theoretical decription of the phenomena and methods, a strong focus is on the practical use a commercial finite element software within computer-based exercises. The covered topics are: <ul> <li>finite element modeling of trusses/beams/frames, plates subject to in-plane/out-of-plane loading and shells</li> <li>convergence properties of displacements and stresses</li> <li>singularities</li> <li>locking effects</li> <li>critical assessment, interpretation and check of results</li> <li>mixed-dimensional coupling of finite elements</li> <li>geometrically linear and non-linear, and material linear and non-linear analyses</li> <li>stability: bifurcation and snap-through problems</li> <li>dynamic problems, modal analyses</li> </ul> </li> </ul>
Literature	Vorlesungsmanuskript, Vorlesungsfolien

Course L3047: Finite elemen	urse L3047: Finite element modeling of structures		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M2033: Subsu	Irface Processes				
Courses					
Title		Тур	Hrs/wk	СР	
Modeling of Subsurface Processes (	L2731)	Recitation Section (small)	3	3	
Subsurface Solute Transport (L272)		Lecture	2	2	
Subsurface Solute Transport (L272)		Recitation Section (large)	1	1	
Module Responsible					
Admission Requirements	None				
<b>Recommended Previous</b>	Basic Mathematics, Hydrology				
Knowledge					
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results			
Professional Competence					
Knowledge	Upon completion of this module, the students will understand the mechanisms controlling solute transport in soil and nature porous media and will be able to work with the equations that govern the fate and transport of solutes in porous media. Analytic numerical and experimental tools and techniques will be used in this module.				
Skills	In addition to the physical insights, the students will be exposed to analytical, experimental and numerical tools and techniques this module. This provides them with an excellent opportunity to improve their skills on multiple fronts which will be useful in the future career.				
Personal Competence					
Social Competence	Teamwork & problem solving				
Autonomy	The students will be involved in writing	g individual reports and presentation. This wi	Il contribute to the	students' ability a	
	willingness to work independently and re-	sponsibly.			
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84			
Credit points	6				
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and	Report				
scale					
Assignment for the	Civil Engineering: Specialisation Structure	al Engineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory				
	Civil Engineering: Specialisation Computational Engineering: Elective Compulsory				
	Environmental Engineering: Core Qualification: Compulsory				
	Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory				
	Process Engineering: Specialisation Proce	ess Engineering: Elective Compulsory			
	Water and Environmental Engineering: Sp	pecialisation Water: Compulsory			
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory				

Course L2731: Modeling of S	ourse L2731: Modeling of Subsurface Processes			
Тур	Recitation Section (small)			
Hrs/wk	3			
СР	3			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Lecturer	Dr. Milad Aminzadeh			
Language	EN			
Cycle	WiSe			
Content	Basic usage and background of chosen computer software to calculate flow and transport in the saturated and unsaturated zone and to analyze field data like pumping test data			
Literature				

Course L2728: Subsurface So	olute Transport
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	Basic physical properties of soil: Definition and quantification; Liquid flow in soils (Darcy's law); Solute transport in soils; Practical analysis to measure dispersion coefficient in soil under different boundary conditions; Advanced topics (e.g. Application of Artificial Intelligence to predict soil salinization)
Literature	- Environmental Soil Physics, by Daniel Hillel - Soil Physics, Sixth Edition, by William A. Jury and Robert Horton

Course L2729: Subsurface So	rse L2729: Subsurface Solute Transport		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Hannes Nevermann		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

## Specialization Computational Engineering

Courses				
<b>Fitle</b>		Тур	Hrs/wk	СР
Steel and Composite Structures (L1	-	Lecture	2	2
Steel and Composite Structures (L1 Steel Bridges (L1097)	205)	Recitation Section (large) Lecture	2 2	2
-	Prof. Marcus Rutner	Lecture	Z	Z
Module Responsible Admission Requirements	None			
-	Basics of steel construction (i.e. Steel Structures I and I	BUBC)		
Knowledge	basics of steel construction (i.e. steel structures I and I	, bobc)		
-	After taking part successfully, students have reached th	e following learning results		
Professional Competence		· · · · · · · · · · · · · · · · · · ·		
-	After successful completition, students can			
-	· · · · · · · · · · · · · · · · · · ·			
	describe the phenomenon of local buckling			
	explain warping torsion			
	illustrate the behaviour of composite structures			
	<ul> <li>specify the principles in design of composite sttr</li> </ul>			
	<ul> <li>sketch the contructions of steel and composite b</li> </ul>	ridges		
Skills	After successful participation students are able to			
	<ul> <li>check stiffened and unstiffened plated structures</li> </ul>			
	• recognize and verify warping tosion in strucures			
	design composite structures			
	<ul> <li>design bridges and o perform the detailing</li> </ul>			
Porconal Competence				
Personal Competence Social Competence	_			
Autonomy				
· · · · · · · · · · · · · · · · · · ·	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering	Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineer	ng: Elective Compulsory		
-	Civil Engineering: Specialisation Coastal Engineering: E	• • •		
	Civil Engineering: Specialisation Water and Traffic: Elec			
	Civil Engineering: Specialisation Computational Engineer			
	International Management and Engineering: Specialisat	•		

Course L1204: Steel and Con	nposite Structures
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	WiSe
Content	<ul> <li>Local-buckling of plated structures</li> <li>Warping torsion</li> <li>Composite-girders, -columns, -slabs, -bridges</li> <li>Principles in composite constructions</li> <li>Bridge-design and -construction</li> </ul>
Literature	Petersen, C.: Stahlbau, 4.Auflage 2013, Springer-Vieweg Verlag Minnert, J. Wagenknecht, G.: Verbundbau-Praxis - Berechnung und Konstruktion nach Eurocode 4, 2.Auflage 2013, Bauwerk Beuth Verlag

Course L1205: Steel and Con	ourse L1205: Steel and Composite Structures		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Marcus Rutner		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1097: Steel Bridges	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	
Language	
Cycle	
Content	Lecture Contents ,Steel Bridge Construction' DrIng. Jörg Ahlgrimm
	- From tendering and contracting to completion - the development of a steel bridge
	- Contents of a bridge static - structural details, examples of analysis in detail:
	-> effective width in regard to the longitudinal stiffeners
	-> Bearing point, bearing stiffener
	-> Crossbeam breakthrough, crossbeam reinforcement
	-> Analysis of the Rib-to-Floorbeam (RF) connection (web-tooth of the floorbeam between trapezoidal shaped Ribs)
	- Steel grades, -designation, testing methods and approval certificates
	- Nondestructive weld inspecting
	- Corrosion protection
	- Bridge bearing - types, format, function, dimensioning, installation
	- Expansion Joints
	- Oscillation of bridge hangers and cables - oscillation damper
	- Opening bridges- Detailed reviews to different assembling procedures and - implements
	- Selective damage events
	Requirements: Basic knowledge in the calculation, dimensioning, and construction of structural elements and joints of constructional steelwork
Literature	
	Herbert Schmidt, Ulrich Schulte, Rainer Zwätz, Lothar Bär:     Ausführung von Stahlbauten
	Petersen, Christian: Stahlbau, Abschnitt Brückenbau
	<ul> <li>Ahlgrimm, J., Lohrer, I.: Erneuerung der Eisenbahnüberführung in Fulda-Horas über die Fulda, Stahlbau 74 (2005), Heft 2, S. 114</li> </ul>

2					
Courses					
Title		Тур	Hrs/wk	СР	
Numerical Methods in Geotechnics (L0375)		Lecture	3	3	
Advanced Foundation Engineering (L0497)		Lecture	2 1	2 1	
Advanced Foundation Engineering		Recitation Section (large)	1	Ţ	
Module Responsible					
Admission Requirements	None				
Recommended Previous	Geotechnics I and II, Mathematics I-III				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the	ne following learning results			
Professional Competence					
Knowledge	After successfully completing the module, students will	be able to			
	<ul> <li>describe individual procedures for the geotechni</li> </ul>	al monitoring of civil engineering mea	sures		
	<ul> <li>reproduce exploration and investigation method</li> </ul>		54105,		
	<ul> <li>select suitable types of field and laboratory tests</li> </ul>		their results		
	<ul> <li>state the differences between various stress and</li> </ul>			variants of the stre	
	and distortion tensor,		igniticative of inte		
	<ul> <li>outline the standard and special soil mechanics</li> </ul>	ests used to determine the stress-stra	in behavior of soi	il	
	<ul> <li>describe continuum models and the resulting bo</li> </ul>			,	
	<ul> <li>as well as define boundary value problems from</li> </ul>		n such a way tha	it they can be solv	
	unambiguously.	the field of geoteenined engineering i		it they can be solv	
	unambiguousiy.				
Skills	Students will be able to				
	<ul> <li>dimension vertical drains for soil improvement of soft soils,</li> <li>calculate depth compaction using various appropriate methods,</li> <li>apply principles of horizontal bearing capacity of piles,</li> <li>verify the internal and external stability of fluid-supported diaphragm walls,</li> <li>evaluate the boundary conditions for the design of a deep excavation and design the individual components excavation,</li> <li>perform, evaluate and interpret tests for the description and classification of soils according to applicable standards,</li> <li>computationally implement numerical algorithms to solve boundary value problems,</li> <li>select and apply the types of analyses depending on the degree of saturation, the impact, and the material behavior</li> <li>determine appropriate model parameters for different possibilities and limitations of material models for the grain st of soils.</li> </ul>				
Demonst Commentance					
Personal Competence	Students can work in groups and support each ather in	finding colutions			
Sucial Competence	Students can work in groups and support each other in				
Autonomy	Students are able to assess their own strengths and we	aknesses and, based on this, organize	their time and le	arning manageme	
	and think in terms of processes.				
Weddeed in U.	Independent Study Time 06. Study Time in Laster 201				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84				
Credit points					
Course achievement					
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structural Engineering				
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineer	• • •			
	Civil Engineering: Specialisation Coastal Engineering: C				
	Civil Engineering: Specialisation Water and Traffic: Elec	tive Compulsory			
	Civil Engineering: Specialisation Computational Engineering: Compulsory				
	International Management and Engineering: Specialisat	ion II. Civil Engineering: Elective Comp	ulsory		

Course L0375: Numerical Me	thods in Geotechnics
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Hans Mathäus Stanford
Language	DE
Cycle	WiSe
Content	Topics:
	<ul> <li>Introduction to numerical soil mechanics</li> <li>Introduction to numerical mathematics</li> <li>Finite Element Method (analysis procedures, algorithms)</li> <li>Finite Element Method (application in geotechnical engineering)</li> </ul>
Literature	<ul> <li>Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden. Springer</li> <li>Wriggers P. (2008): Nonlinear Finite Element Methods. Springer</li> <li>Deutsche Gesellschaft für Geotechnik e.V. (Hrsg., 2014): Empfehlungen des Arbeitskreises "Numerik in der Geotechnik". Ernst &amp; Sohn</li> </ul>

Course L0497: Advanced Fou	Indation Engineering
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	<ul> <li>Vertical drains</li> <li>Piles</li> <li>Ground improvement (Deep Compaction, Soil mixing)</li> <li>Vibration driving</li> <li>Jet grouting</li> <li>Slurry wall</li> <li>Deep excavation</li> </ul>
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>EAB (1988): Empfehlungen des Arbeitskreises Baugruben</li> <li>Grundbau-Taschenbuch, Teil 1-3, (1997), Ernst &amp; Sohn Verlag</li> </ul>

Course L0498: Advanced Fou	ourse L0498: Advanced Foundation Engineering		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Jürgen Grabe		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

		25				
Courses						
litle .			т	Тур	Hrs/wk	СР
Concrete Structures (L0579)				Seminar	1	1
Structural Concrete Members (L05	(7)		L	ecture	2	3
Structural Concrete Members (L05	/8)		R	ecitation Section (large)	2	2
Module Responsible	NN					
Admission Requirements	None					
<b>Recommended Previous</b>	Basics of structural	analysis, conception a	nd dimensioning of struc	tural concrete		
Knowledge						
	Modules: Reinforced	d Concrete Structures I	+II, Structural Analysis I-	+II, Mechanics I+II		
Educational Objectives	After taking part su	iccessfully students ha	ve reached the following	learning results		
Professional Competence	, iter taking part ba	iecessiany, stadents na	ie reached the following	i carring results		
	The students broad	lon their skills in struct		ally in the field of buildings	(houses roofs ha	alls) They dispose
Knowledge				and structural members t		
	the knowledge for t	the conception and des	ight of concrete buildings			
Skills	The students are al	ble to apply procedure	s of the conception and	dimensioning to to practic	al problems of st	ructural engineeri
	They are capable to draft concrete buildings and to design them for general action effects and to plan the			their detailing a		
	execution. Moreove	er, they can make desig	n and construction sket	ches and draw up technica	l descriptions.	
Demonal Commetence						
Personal Competence						
Social Competence	The students are ab	Die to obtain results of .	nigh quality in teamwork			
				sioning tasks of structures	under the guidance	e of tutors.
Autonomy	The students are ab	ble to carry out comple:	x conception and dimens		under the guidand	e of tutors.
Autonomy	The students are ab		x conception and dimens		under the guidanc	e of tutors.
Autonomy	The students are ab Independent Study 6	ble to carry out comple: Time 110, Study Time	x conception and dimens		under the guidanc	e of tutors.
Autonomy Workload in Hours	The students are ab Independent Study 6 Compulsory Bonus	ble to carry out comple: Time 110, Study Time Form	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement	The students are ab Independent Study 6 Compulsory Bonus No None	ble to carry out comple: Time 110, Study Time	x conception and dimens in Lecture 70 Description		under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination	The students are ab Independent Study 6 Compulsory Bonus No None Written exam	ble to carry out comple: Time 110, Study Time Form	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidanc	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and	The students are ab Independent Study 6 Compulsory Bonus No None Written exam	ble to carry out comple: Time 110, Study Time Form	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidanc	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination	The students are ab Independent Study 6 Compulsory Bonus No None Written exam	ble to carry out comple: Time 110, Study Time Form	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes	ble to carry out comple: Time 110, Study Time Form Presentation	x conception and dimens in Lecture 70 Description	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp	ble to carry out comple: Time 110, Study Time Form Presentation Specialisation Structural	x conception and dimens in Lecture 70 Description Es werden 2 Re	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp	ble to carry out comple: Time 110, Study Time Form Presentation Specialisation Structural Specialisation Geotechn	x conception and dimens in Lecture 70 Description Es werden 2 Re Engineering: Compulsor	sioning tasks of structures	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp	ble to carry out comple: Time 110, Study Time Form Presentation Specialisation Structural Specialisation Geotechn Specialisation Coastal En	x conception and dimens in Lecture 70 Description Es werden 2 Re Engineering: Compulsor ical Engineering: Elective	sioning tasks of structures eferate ausgegeben ry e Compulsory ipulsory	under the guidand	e of tutors.
Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	The students are ab Independent Study 6 Compulsory Bonus No None Written exam 120 minutes Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp Civil Engineering: Sp	ble to carry out complex Time 110, Study Time Form Presentation Specialisation Structural Specialisation Geotechn Specialisation Coastal Er Specialisation Water and	x conception and dimens in Lecture 70 Description Es werden 2 Re Engineering: Compulsor ical Engineering: Elective ngineering: Elective Com	sioning tasks of structures eferate ausgegeben ry e Compulsory ipulsory lsory	under the guidand	e of tutors.

Course L0579: Concrete Stru	ictures
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	NN
Language	DE
Cycle	WiSe
Content	With help of a project teamwork the subjects of the course "Concrete Structures" is practiced, discussed and presented.
Literature	- Projektbezogene Unterlagen werden abgegeben.

Course L0577: Structural Cor	ncrete Members
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	NN
Language	DE
Cycle	WiSe
Content	<ul> <li>skyscrapers: structural elements</li> <li>actions on structrues</li> <li>bracing systems</li> <li>design orf slabs (line and point supported plates and floor slabs)</li> <li>membranes and deep beams</li> <li>folded plates and shells</li> <li>truss models</li> <li>reinforced and prestressed members</li> </ul>
	<ul> <li>Vorlesungsunterlagen können im STUDiP heruntergeladen werden</li> <li>Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010</li> <li>König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst &amp; Sohn, Berlin 2003</li> <li>Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005</li> <li>Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012</li> <li>Deutscher Ausschuss für Stahlbeton: Heft 240: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen von Stahlbetontragwerken, Verlag Ernst &amp; Sohn, Berlin 1978</li> <li>Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalender 1992, Teil I, 287-366, Verlag Ernst &amp; Sohn, Berlin 1992</li> <li>Stiglat/Wippel: Platten. Verlag Ernst &amp; Sohn, Berlin, 1973</li> <li>Schlaich J.; Schäfer K.: Konstruieren im Stahlbetonbau. Betonkalender 1998, Teil II, S. 721ff, Verlag Ernst &amp; Sohn, Berlin, 1998</li> <li>Dames KH.: Rohbauzeichnungen Bewehrungszeichnungen. Bauverlag, Wiesbaden 1997</li> </ul>

Course L0578: Structural Concrete Members		
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	NN	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Iodule M1748: Const	
Courses	
Fitle Construction Robotics (L2867)	TypHrs/wkCPProject-/problem-based Learning66
Module Responsible	Prof. Kay Smarsly
Admission Requirements	None
<b>Recommended Previous</b>	Basics of project-oriented programming
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Basics of robotics
	Applications in civil engineering
	Kinematics
Skills	Use of specific hardware
	Development of software routines
	Python programming language
	Image processing
	Basics of localization (LIDAR, SLAM)
Personal Competence	
Social Competence	
	Communication skills
Autonomy	Independent work
	Independent decisions
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	ca. 10 Seiten
scale	
•	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Following Curricula	
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Computational Engineering: Elective Compulsory
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory
	Mechatronics: Core Qualification: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory

Тур	Project-/problem-based Learning
Hrs/wk	
CP	
	Independent Study Time 96, Study Time in Lecture 84
	Prof. Kay Smarsly, Jan Stührenberg
Language	
Cycle	
Content	1. Introduction: Robotics in civil engineering
	2. Presentation of potential topics
	3. Programming of algorithms in Python
	4. Application of software systems: LINUX distribution, ROS, CloudCompare,
	5. Application of hardware systems: Petoi Bittle Dog, Raspberry Pi, Arduino, sensing
	6. Topics considered for robotics using the Petoi Bittle Dog:
	1. Movement
	2. Use of sensors (camera, infrared,)
	3. Data structures/data acquisition
	4. Programming
	7. Topics technically relevant to building inspection:
	1. Geodetic evaluations
	2. Image processing
	3. Localization
Literature	Bock/Linner: Construction Robotics
	Verl et al.: Soft Robotics
	Pasquale: New Laws of robotics

Module M2033: Subs	urface Processes			
Courses				
Title		Тур	Hrs/wk	СР
Modeling of Subsurface Processes	(L2731)	Recitation Section (small)	3	3
Subsurface Solute Transport (L272	8)	Lecture	2	2
Subsurface Solute Transport (L272	9)	Recitation Section (large)	1	1
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic Mathematics, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Upon completion of this module, the stu	Idents will understand the mechanisms controlli	ng solute transpor	t in soil and natur
		h the equations that govern the fate and transpor		
	, numerical and experimental tools and tech	hniques will be used in this module.		
Skills		udents will be exposed to analytical, experimenta		
		xcellent opportunity to improve their skills on mu	ltiple fronts which	will be useful in th
	future career.			
Personal Competence				
Social Competence	Teamwork & problem solving			
Autonomy	The students will be involved in writing	individual reports and presentation. This will o	contribute to the	students' ability a
	willingness to work independently and res	ponsibly.		
Workload in Hours	Independent Study Time 96, Study Time in	n Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Report			
scale				
Assignment for the	Civil Engineering: Specialisation Structural	l Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechn	ical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal En	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and	d Traffic: Elective Compulsory		
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory		
	Environmental Engineering: Core Qualifica			
		nmental Process Engineering: Elective Compulsor	у	
	Process Engineering: Specialisation Process	ss Engineering: Elective Compulsory		
	Water and Environmental Engineering: Sp	ecialisation Water: Compulsory		

Course L2731: Modeling of S	ubsurface Processes
Тур	Recitation Section (small)
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Milad Aminzadeh
Language	EN
Cycle	WiSe
Content	Basic usage and background of chosen computer software to calculate flow and transport in the saturated and unsaturated zone
	and to analyze field data like pumping test data
Literature	

Course L2728: Subsurface So	olute Transport
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	Basic physical properties of soil: Definition and quantification; Liquid flow in soils (Darcy's law); Solute transport in soils; Practical analysis to measure dispersion coefficient in soil under different boundary conditions; Advanced topics (e.g. Application of Artificial Intelligence to predict soil salinization)
Literature	- Environmental Soil Physics, by Daniel Hillel - Soil Physics, Sixth Edition, by William A. Jury and Robert Horton

Course L2729: Subsurface So	Irse L2729: Subsurface Solute Transport	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Hannes Nevermann	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M1845: Thin-	walled structures			
	walled structures			
Courses				
Title		Тур	Hrs/wk	СР
Thin-walled structures (L1199)		Lecture	2	3
Thin-walled structures (L3045)		Recitation Section (large)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge	Structural Analysis I			
	Structural Analysis II			
	Finite Element Methods			
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, the	students can express the basic aspects of	the load-carryin	g behaviour of thin
	walled structures.			
Skille	After successful completion of this module, the s	tudents will be able to predict load-carrying	n behaviour of th	ain-walled structure
5/11/3	using appropriate analytical and coputational met			ini-walled scructure
		nous.		
Personal Competence				
Social Competence	Students can			
	<ul> <li>participate in subject-specific and interdisci</li> </ul>	plinary discussions,		
	<ul> <li>defend their own work results in front of other</li> </ul>	ners		
	<ul> <li>promote the scientific development of colle</li> </ul>	aques		
	<ul> <li>Furthermore, they can give and accept prot</li> </ul>	•		
Autonomy	Students are able to gain knowledge of the subject			
	they are able to structure the solution process for	problems in the area of modelling and analy	sis of thin-walled	d structures.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineeri	ng: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng	ineering: Elective Compulsory		
	Civil Engineering: Specialisation Computational Er	ngineering: Compulsory		
	Civil Engineering: Specialisation Structural Engine	ering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisation	n Simulation Technology: Elective Compulsor	ry	

Тур	Lecture
Hrs/wk	
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	Plates loaded in-plane
	Governing equations (equilibrium, kinematics, constitutive law)
	Differential equation
	Airy stress function
	Plane stress / plane strain
	Structural behaviour of plates loaded in-plane
	<ul> <li>finite elements for plates loaded in-plane, modelling apsects, interpretation and critical assessment of results</li> </ul>
	Plates in bending
	Governing equations (equilibrium, kinematics, constitutive law)
	Differential equation
	Navier solution / Fourier series expansion
	Approximation procedures
	Circular and rectangular plates
	Structural behaviour of plates in bending
	• finite elements for plates in bending, modelling apsects, interpretation and critical assessment of results
	Shells
	Phenomenona of the structural behaviour of shells
	Membrane and bending theory
	<ul> <li>Equilibrium equations of shells of revolution</li> <li>Stress resultants and deformations of the spherical shell, the half spherical shell, and the cylindrical shell</li> </ul>
	<ul> <li>Stress resultants and deformations of the spherical shell, the nan spherical shell, and the cylindrical shell</li> <li>finite elements for shells</li> </ul>
	Stability problems (overview)
	Plate buckling
	Shell buckling
Literature	Vorlesungsmanuskript
	Basar, Y.: Krätzig, W.B. (1985): Mechanik der Flächentragwerke. Vieweg-Verlag, Braunschweig, Wiesbaden
	<ul> <li>Girkmann, K. (1963): Flächentragwerke, Springer Verlag, Wien, 1963, unveränderter Nachdruck 1986</li> </ul>
	• Zienkiewicz, O.C. (1977): The Finite Element Method in Enginieering Science. McGraw-Hill, London

Course L3045: Thin-walled st	urse L3045: Thin-walled structures	
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Түр	Hrs/wk	СР
Hydraulic Models (L0813)		Project-/problem-based Learning	1	1
Modelling of Waves (L0812)		Project-/problem-based Learning	1	1
Modelling of Flow in Rivers and Est	Jaries (L0810)	Lecture	3	4
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>	Coastal Hydraulic Engineering I			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follo	wing learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to define in detail the basic processes t	hat are related to the modelling	of flows in hy	ydraulic engineerir
	Besides, they can describe the basic aspects of numerical m	odelling and actual numerical mod	els for the sir	nulation of flows a
	waves.			
Skille	Students are able to apply hydrodynamic-numerical models to	o practical hydraulic opgingering ta	sks	
JKIIIS	students are able to apply hydrodynamic-humenear models a	, practical hydraulic engineering ta	585.	
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in si	mple applied problems. Additionaly	, they will be	able to work in tea
	with others.			
Autonomy	The students will be able to independently extend their know	edge and apply it to new problems		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 3 hours. The examinati	on includes tasks with respect to	the general ι	understanding of t
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Election	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: El	ective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective	Compulsory		
	Civil Engineering: Specialisation Computational Engineering:	Compulson		

Course L0813: Hydraulic Models	
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>Fundamentals of hydraulic models</li> <li>Model laws</li> <li>Pi theorem of Buckingham</li> <li>Practical examples of hydraulic models</li> </ul>
Literature	Strobl, Zunic: Wasserbau, Kap. 11 Hydraulische Modelle, Springer

Course L0812: Modelling of	Waves		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР	1		
Workload in Hours	ependent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	DE/EN		
Cycle	SoSe		
Content	<ul> <li>Waves, interactions with shallow water and constructions</li> <li>Wave theories</li> <li>Sea state and surges</li> <li>Development of waves</li> <li>Wave spectra</li> <li>Modelling of Waves / phase averaged and phase resolved models</li> <li>Application of a phase averaged model for wave prediction (SWAN)</li> <li>Application of phase resolved wave models (Mike)</li> </ul>		
Literature	Vorlesungsumdruck		

Course L0810: Modelling of I	
	Lecture
Hrs/wk	
СР	4
	Independent Study Time 78, Study Time in Lecture 42
	Prof. Edgar Nehlsen, Prof. Peter Fröhle
Language	
Cycle	SoSe Introduction to numerical flow modelling
	<ul> <li>Processes affecting tht flow</li> <li>Examples and applications of numerical models</li> <li>Procedure of numerical modelling</li> <li>Model concept</li> <li>Basic equations of hydrodynamics</li> <li>Saint-Venant equations</li> <li>Euler Equations</li> <li>Navier-Stokes equations</li> <li>Reynolds-averaged Navier-Stokes equations</li> <li>Shallow water equations</li> </ul>
	Solving schemes   Numerical discretization  Solution algorithms  Convergence
Literature	Vorlesungsskript
	Bund der Ingenieure für Wasserwirtschaft, Abfallwirtschaft und Kulturbau (1997): Hydraulische Berechnung von naturnaher Fließgewässern. Düsseldorf: BWK (BWK-Merkblatt). Chow, Ven-te (1959): Open-channel Hydraulics. New York usw.: McGraw-Hill (McGraw-Hill Civil Engineering Series). Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019a): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 1: Geodaten in der Fließgewässermodellierung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-1).
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019b): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 2: Bedarfsgerechte Datenerfassung und -aufbereitung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-2).
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019c): Merkblatt DWA-M 543-3 Geodaten in de Fließgewässermodellierung - Teil 3: Aspekte der Strömungsmodellierung und Fallbeispiele. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-3).
	Hervouet, Jean-Michel (2007): Hydrodynamics of free surface flows. Modelling with the finite element method. Chichester: Wiley Online verfügbar unter http://www.loc.gov/catdir/enhancements/fy0741/2007296953-b.html.
	IAHR (2015): Professional Specifications for Physical and Numerical Studies in Environmental Hydraulics. In: Hydrolink (3/2015), S 90-92.
	Olsen, Nils Reidar B. (2012): Numerical Modelling and Hydraulics. 3. Aufl. Department of Hydraulic and Environmental Engineering The Norwegian University of Science and Technology.
	Szymkiewicz, Romuald (2010): Numerical modeling in open channel hydraulics. Dordrecht: Springer (Water science and technology library, 83).
	van Waveren, Harold (1999-): Good modelling practice handbook. [Utrecht], Lelystad, Den Haag: STOWA; Rijkswaterstaat-RIZA SDU, afd. SEO/RIZA [etc. distr.] (Nota, nr. 99.036).
	Zielke, Werner (Hg.) (1999): Numerische Modelle von Flüssen, Seen und Küstengewässern. Deutscher Verband für Wasserwirtschaft und Kulturbau. Bonn: Wirtschafts- und VerlGes. Gas und Wasser (Schriftenreihe des Deutschen Verbandes für Wasserwirtschaft und Kulturbau, 127).

Courses				
Title		Тур	Hrs/wk	СР
Digital Twinning in Civil Engineering (L3136)		Lecture	2	2
Digital Twinning in Civil Engineerin	g (L3137)	Seminar	2	4
Module Responsible	Alexander Chmelnizkij			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	20 min presentation and 5 pages handou	t		
scale				
Assignment for the	Civil Engineering: Specialisation Compute	ational Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal I	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structura	al Engineering: Elective Compulsory		

Course L3136: Digital Twinning in Civil Engineering		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly	
Language	DE	
Cycle	SoSe	
Content		
Literature		

Course L3137: Digital Twinn	ourse L3137: Digital Twinning in Civil Engineering		
Тур	Seminar		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Lecturer	Alexander Chmelnizkij, Prof. Bastian Oesterle, Prof. Kay Smarsly		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
ïtle		Тур	Hrs/wk	СР
iteel Construction Project (L1206)		Project Seminar	4	6
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
<b>Recommended Previous</b>	Steel and Composite Structures			
Knowledge				
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
Knowledge	Students are able to prepare a part of th	e whole project and explain it to the others.		
Skills	Students can produce sketches and calculations of their part of the project. They are able to adjust their work in reaction			
	changing conditions resulting from other	participants of the project.		
Personal Competence				
Social Competence	Students can present their results to other members of the group. They have the ability to work for a broad agreement with respect to intergroup dependencies.			
	They can distribute and process tasks in	dependently.		
Autonomy	Students can handle their part of the pro	ject on their own resposibility-		
Workload in Hours	Independent Study Time 124, Study Tim	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	approx. 15-20 pages (without appendix)			
scale				
Assignment for the	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Structur	al Engineering: Compulsory		
	Civil Engineering: Specialisation Comput	ational Engineering: Elective Compulsory		

Course L1206: Steel Construction Project		
Project Seminar		
4		
6		
Independent Study Time 124, Study Time in Lecture 56		
Prof. Marcus Rutner		
DE		
SoSe		
Design of a big construction project (i.e skyscraper, large bridge, roof of a stadiuim) in small groups		
Wird je nach Projekt individuell angegeben.		

Courses					
Title		Тур	Hrs/wk	СР	
Marine Geotechnics (L0548)		Lecture	1 2	2	
Marine Geotechnics (L0549) Steel Structures in Foundation and	Hydraulic Engineering (L1146)	Recitation Section (large) Lecture	2	2	
Module Responsible			_		
Admission Requirements					
Recommended Previous	Complete modules: Geotechnics I-III, Math	ematics I-III			
Knowledge					
	Courses: Soil laboratory course				
Educational Objectives	After taking part successfully, students have	ve reached the following learning results			
Professional Competence					
Knowledge	The students get a deeper knowledge of steel and ground engineering as well as constructions knowledge concerning quay wa				
	Furthermore, the students get all the necessary knowledge to design singular construction elements for sheet pile walls know how to choose the right construction elements depending on the influencing conditions.				
Skille	Furthermore, the students are able to din	ancien cheet pile well construction regarding	all construction alo	monte to chooco t	
JKIIIS	Furthermore, the students are able to dimension sheet pile wall construction regarding all construction elements, to choose the suitable construction elements with respect to the influencing conditions, to design all kinds of sheet pile walls (wave sheet pile				
	walls and combined sheet pile walls) and to dimension all construction elements and connections.				
Personal Competence					
Social Competence					
Autonomy	Students are able to assess their own stren	ngths and weaknesses and organize their time	and learning manage	ement based on thi	
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	Civil Engineering: Specialisation Geotechni	cal Engineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Coastal Er	ngineering: Compulsory			
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory			

Course L0548: Marine Geote	chnics			
Тур	Lecture			
Hrs/wk	1			
СР				
Workload in Hours	ependent Study Time 46, Study Time in Lecture 14			
Lecturer	Prof. Jürgen Grabe			
Language	DE			
Cycle	SoSe			
Content	<ul> <li>Geotechnical investigation an description of the seabed</li> <li>Foundations of Offshore-Constructions</li> <li>cCliff erosion</li> <li>Sea dikes</li> <li>Port structures</li> <li>Flood protection structures</li> </ul>			
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst &amp; Sohn, Berlin</li> </ul>			

## Module Manual M.Sc. "Civil Engineering"

Course L0549: Marine Geote	rse L0549: Marine Geotechnics		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Jürgen Grabe		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L1146: Steel Structur	Course L1146: Steel Structures in Foundation and Hydraulic Engineering		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Frank Feindt		
Language	DE		
Cycle	SoSe		
Content	Design of a sheet pile wall, design of a combined sheet pile wall, piles, walings, connections, fatigue		
Literature	EAU 2012, EA-Pfähle, EAB		

Courses					
		-	11		
Title Computational Structural Dynamics (L0282)		<b>Typ</b> Lecture	Hrs/wk 3	<b>CP</b> 4	
Computational Structural Dynamics		Recitation Section (small)	1	2	
	Prof. Alexander Düster		_	_	
Admission Requirements					
		ns is recommended			
Kecommended Previous	Knowledge of partial differential equation	ns is recommended.			
	After taking part successfully, students	have reached the following learning results			
	After taking part successfully, students	have reached the following learning results			
Professional Competence					
Knowledge	Students are able to	I procedures for problems of structural dynamics			
		I procedures for problems of structural dynamics.			
		nt programs to solve problems of structural dynam ructural dynamics, to identify them in a given situ		in their mathemati	
	and mechanical background.	ructural dynamics, to identify them in a given site	ation and to expla		
	and mechanical background.				
Skills	Students are able to				
	+ model problems of structural dynamics.				
	+ select a suitable solution procedure for a given problem of structural dynamics.				
+ apply computational procedures to solve problems of structural dynamics.					
	+ verify and critically judge results of co	mputational structural dynamics.			
Demonal Commentance					
Personal Competence					
Social Competence	Students are able to				
	+ solve problems in heterogeneous grou				
	+ present and discuss their results in fro				
	+ give and accept professional construc	uve criticism.			
Autonomy	Students are able to				
	+ assess their knowledge by means of e	exercises and E-Learning.			
	+ acquaint themselves with the necessa	ary knowledge to solve research oriented tasks.			
	+ to transform the acquired knowledge	to similar problems.			
Workload in Hours	Independent Study Time 124, Study Tim	e in Lecture 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	2h				
scale					
	Civil Engineering: Specialisation Comput	ational Engineering: Elective Compulsory			
-		ing: Specialisation II. Mechatronics: Elective Comp	ulsory		
· ····································	Materials Science: Specialisation Modeli	• ·	,		
	Mechatronics: Technical Complementary				
		ng: Core Qualification: Elective Compulsory			
		ecialisation Simulation Technology: Elective Compu	llsony		

Course L0282: Computationa	al Structural Dynamics
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	SoSe
Content	1. Motivation
	2. Basics of dynamics
	3. Time integration methods
	4. Modal analysis
	5. Fourier transform
	6. Applications
L ite and and	1117 L Dette Finite Flammate Matheday Caringry 2002
Literature	[1] KJ. Bathe, Finite-Elemente-Methoden, Springer, 2002.
	[2] J.L. Humar, Dynamics of Structures, Taylor & Francis, 2012.

Course L0283: Computationa	urse L0283: Computational Structural Dynamics		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Alexander Düster		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses						
Title		Тур	Hrs/wk	СР		
Numerical Algorithms in Structural	Mechanics (L0284)	Lecture	2	3		
Numerical Algorithms in Structural	Mechanics (L0285)	Recitation Section (small)	2	3		
Module Responsible	Prof. Alexander Düster					
Admission Requirements	None					
<b>Recommended Previous</b>	Knowledge of partial differential equations	is recommended.				
Knowledge						
Educational Objectives	After taking part successfully, students have	ve reached the following learning results				
Professional Competence						
Knowledge	Students are able to					
		nms that are used in finite element programs.				
	+ explain the structure and algorithm of fir					
		s, to identify them in a given situation and to e	plain their mather	matical and comput		
	science background.					
Skills	Students are able to					
	+ construct algorithms for given numerical methods.					
	+ select for a given problem of structural mechanics a suitable algorithm.					
	+ apply numerical algorithms to solve problems of structural mechanics.					
	+ implement algorithms in a high-level programming languate (here C++).					
	+ critically judge and verfiy numerical algo	rithms.				
Personal Competence						
Social Competence	Students are able to					
	+ solve problems in heterogeneous groups.					
	+ present and discuss their results in front of others.					
	+ give and accept professional constructive	e criticism.				
Autonomy	Students are able to					
	+ assess their knowledge by means of exe	rcises and E-Learning.				
	+ acquaint themselves with the necessary	knowledge to solve research oriented tasks.				
	+ to transform the acquired knowledge to	similar problems.				
	Independent Study Time 124, Study Time i	n Lecture 56				
Credit points						
Course achievement	None					
Examination	Written exam					
Examination duration and scale	2h					
	Civil Engineering: Specialisation Computati	onal Engineering: Elective Compulsory				
Following Curricula	Materials Science: Specialisation Modeling:					
	Naval Architecture and Ocean Engineering:					
	Technomathematics: Specialisation III. Eng					
		alisation Simulation Technology: Elective Comput	sorv			

Course L0284: Numerical Alg	jorithms in Structural Mechanics
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	SoSe
Content	1. Motivation
	2. Basics of C++
	3. Numerical integration
	4. Solution of nonlinear problems
	5. Solution of linear equation systems
	6. Verification of numerical algorithms
	7. Selected algorithms and data structures of a finite element code
Literature	[1] D. Yang, C++ and object-oriented numeric computing, Springer, 2001.
	[2] KJ. Bathe, Finite-Elemente-Methoden, Springer, 2002.

Course L0285: Numerical Alg	jorithms in Structural Mechanics
Тур	Recitation Section (small)
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0604: High-	Order FEM					
Courses						
Title			Тур		Hrs/wk	СР
High-Order FEM (L0280) High-Order FEM (L0281)			Lecture Recitation Se	ection (large)	3	4 2
Module Responsible	Prof. Alexander Düst	ter		(	_	
Admission Requirements	None					
Recommended Previous		l differential equations i	is recommended			
Knowledge	Knowledge of partia		is recommended.			
Educational Objectives	After taking part su	cessfully students hav	e reached the following learning r	esults		
Professional Competence	, neer canny pare bat	.cessiany, stadents nav		courto		
	Students are able to	1				
Kilowicage			) finite element procedures.			
	-	r finite element procedu				
			edures, to identify them in a give	ven situation an	d to explain the	ir mathematical a
	mechanical backgro	und.				
Skills	Students are able to	)				
			ems of structural mechanics.			
			echanics a suitable finite element	procedure.		
	_	' sults of high-order finite				
			ite elements to new problems.			
Personal Competence						
Social Competence	Students are able to	)				
	+ solve problems in	heterogeneous groups				
	+ present and discu	iss their results in front	of others.			
	+ give and accept p	professional constructive	e criticism.			
Autonomy	Students are able to					
		ledge by means of exer				
			knowledge to solve research orien	ited tasks.		
	+ to transform the a	acquired knowledge to s	similar problems.			
Workload in Hours	Independent Study .	Time 124, Study Time ii	a Lecture 56			
Credit points						
Course achievement	Compulsory Bonus	Form	Description			
	No 10 %	Presentation	Forschendes Lernen			
Examination	Written exam					
Examination duration and	120 min					
scale						
Assignment for the	Civil Engineering: Sp	pecialisation Computation	onal Engineering: Elective Compul	sory		
Following Curricula	International Manag	ement and Engineering	: Specialisation II. Product Develop	pment and Produ	ction: Elective Co	ompulsory
	Materials Science: S	pecialisation Modeling:	Elective Compulsory			
	Mechanical Enginee	ring and Management:	Specialisation Product Developme	nt and Productio	n: Elective Comp	ulsory
	Mechatronics: Techr	nical Complementary Co	ourse: Elective Compulsory			
	Product Development	nt, Materials and Produc	ction: Core Qualification: Elective (	Compulsory		
	Naval Architecture a	and Ocean Engineering:	Core Qualification: Elective Comp	ulsory		
			neering Science: Elective Compute	sory		
	Theoretical Mechani	cal Engineering: Core Q	ualification: Elective Compulsory			

Course L0280: High-Order FE	:M
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	SoSe
Content	1. Introduction
	2. Motivation
	3. Hierarchic shape functions
	4. Mapping functions
	5. Computation of element matrices, assembly, constraint enforcement and solution
	6. Convergence characteristics
	7. Mechanical models and finite elements for thin-walled structures
	8. Computation of thin-walled structures
	9. Error estimation and hp-adaptivity
	10. High-order fictitious domain methods
Literature	[1] Alexander Düster, High-Order FEM, Lecture Notes, Technische Universität Hamburg-Harburg, 164 pages, 2014
	[2] Barna Szabo, Ivo Babuska, Introduction to Finite Element Analysis - Formulation, Verification and Validation, John Wiley & Sons,
	2011

Course L0281: High-Order FE	EM
Тур	Recitation Section (large)
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Structural Dynamics (L1202)LStructural Dynamics (L1203)RFracture mechanics and fatigue in steel structures (L0564)L	yp ecture ecitation Section (large) ecture ecitation Section (large)	<b>Hrs/wk</b> 2 2 1	<b>СР</b> 2		
Structural Dynamics (L1202)       L         Structural Dynamics (L1203)       R         Fracture mechanics and fatigue in steel structures (L0564)       L         Fracture mechanics and fatigue in steel structures (L0565)       R         Module Responsible       Prof. Bastian Oesterle         Admission Requirements       None         Recommended Previous       Knowledge of linear structural analysis of statically determinate         Differential equations I       Educational Objectives         After taking part successfully, students have reached the following         Professional Competence       Knowledge         Knowledge       After successful completion of this module, the student can explirespective methods.         Skills       After successful completion of this module, the students will b dynamics loading using the appropriate computational approaches         Personal Competence       Kills	ecture ecitation Section (large) ecture	2 2			
Structural Dynamics (L1203)       R         Fracture mechanics and fatigue in steel structures (L0564)       L         Fracture mechanics and fatigue in steel structures (L0565)       R         Module Responsible       Prof. Bastian Oesterle         Admission Requirements       None         Recommended Previous       Knowledge of linear structural analysis of statically determinate Differential equations I         Educational Objectives       After taking part successfully, students have reached the following         Professional Competence       Knowledge         Knowledge       After successful completion of this module, the student can explirespective methods.         Skills       After successful completion of this module, the students will b dynamics loading using the appropriate computational approaches         Personal Competence       Viramics loading using the appropriate computational approaches	ecitation Section (large) ecture	2	2		
Fracture mechanics and fatigue in steel structures (L0564)       L         Fracture mechanics and fatigue in steel structures (L0565)       R         Module Responsible       Prof. Bastian Oesterle         Admission Requirements       None         Recommended Previous       Knowledge of linear structural analysis of statically determinate Differential equations I         Educational Objectives       After taking part successfully, students have reached the following         Professional Competence       Knowledge         Knowledge       After successful completion of this module, the student can explirespective methods.         Skills       After successful completion of this module, the students will be dynamics loading using the appropriate computational approaches         Personal Competence       After successful completion of this module, the students will be dynamics loading using the appropriate computational approaches	ecture				
Fracture mechanics and fatigue in steel structures (L0565)       R         Module Responsible       Prof. Bastian Oesterle         Admission Requirements       None         Recommended Previous       Knowledge of linear structural analysis of statically determinate         Differential equations I       Differential equations I         Educational Objectives       After taking part successfully, students have reached the following         Professional Competence       Knowledge         Knowledge       After successful completion of this module, the student can expline respective methods.         Skills       After successful completion of this module, the students will be dynamics loading using the appropriate computational approaches         Personal Competence       After successful completion of this module, the students will be dynamics loading using the appropriate computational approaches		1	2		
Module Responsible         Prof. Bastian Oesterle           Admission Requirements         None           Recommended Previous         Knowledge of linear structural analysis of statically determinate Differential equations I           Educational Objectives         After taking part successfully, students have reached the following           Professional Competence         After successful completion of this module, the student can explare           Skills         After successful completion of this module, the student swill be dynamics loading using the appropriate computational approaches           Personal Competence         After successful completion of this module, the students will be dynamics loading using the appropriate computational approaches	ecitation Section (large)		1		
Admission Requirements       None         Recommended Previous       Knowledge of linear structural analysis of statically determinate         Differential equations I       Differential equations I         Educational Objectives       After taking part successfully, students have reached the following         Professional Competence       Knowledge         Knowledge       After successful completion of this module, the student can explicitly respective methods.         Skills       After successful completion of this module, the students will b dynamics loading using the appropriate computational approaches         Personal Competence       Image: Skills		1	1		
Recommended Previous         Knowledge of linear structural analysis of statically determinate           Knowledge         Differential equations I           Educational Objectives         After taking part successfully, students have reached the following           Professional Competence         Knowledge           Knowledge         After successful completion of this module, the student can expline respective methods.           Skills         After successful completion of this module, the students will be dynamics loading using the appropriate computational approaches           Personal Competence         Image: Skills					
Knowledge       Differential equations I         Educational Objectives       After taking part successfully, students have reached the following         Professional Competence       After successful completion of this module, the student can expli- respective methods.         Skills       After successful completion of this module, the students will b dynamics loading using the appropriate computational approaches					
Educational Objectives       After taking part successfully, students have reached the following         Professional Competence       After successful completion of this module, the student can explicitly respective methods.         Skills       After successful completion of this module, the students will b dynamics loading using the appropriate computational approaches         Personal Competence       Image: Competence	and indeterminate structu	ires; Mechanics	I/II, Mathematics		
Professional Competence       After successful completion of this module, the student can expline respective methods.         Skills       After successful completion of this module, the students will be dynamics loading using the appropriate computational approaches         Personal Competence       Personal Competence					
Professional Competence       After successful completion of this module, the student can expline respective methods.         Skills       After successful completion of this module, the students will be dynamics loading using the appropriate computational approaches         Personal Competence       Personal Competence	learning results				
Knowledge       After successful completion of this module, the student can expl         respective methods.         Skills         After successful completion of this module, the students will b         dynamics loading using the appropriate computational approaches         Personal Competence	icaning results				
respective methods.         Skills         After successful completion of this module, the students will b dynamics loading using the appropriate computational approaches         Personal Competence	ain the basic aspects of dy	namic effects o	n structures and		
Skills After successful completion of this module, the students will b dynamics loading using the appropriate computational approaches					
<ul><li>participate in subject-specific and interdisciplinary discussio</li><li>defend their own work results in front of others</li></ul>	and methods.	ponse of materi	al and structures		
<ul> <li>promote the scientific development of colleagues</li> </ul>	<ul> <li>promote the scientific development of colleagues</li> </ul>				
<ul> <li>Furthermore, they can give and accept professional constru-</li> </ul>	ctive criticism				
Autonomy Students are able to gain knowledge of the subject area from give	n and other sources and ar	nly it to new pr	oblems Furthermo		
	Students are able to gain knowledge of the subject area from given and other sources and apply it to new problems. Furthermore they are able to structure the solution process for problems in the area of Structural Analysis.				
they are able to structure the solution process for problems in the	area of Scructural Analysis.				
Workload in Hours Independent Study Time 96, Study Time in Lecture 84					
Credit points 6					
Course achievement None					
Examination Written exam					
Examination duration and 150 min					
scale					
Assignment for the Civil Engineering: Specialisation Structural Engineering: Compulsor	у				
Following Curricula Civil Engineering: Specialisation Geotechnical Engineering: Elective	-				
Civil Engineering: Specialisation Coastal Engineering: Elective Com					
Civil Engineering: Specialisation Water and Traffic: Elective Compu					
Civil Engineering: Specialisation water and Trant. Elective compu-	-				
International Management and Engineering: Specialisation Computational Engineering: Electric		ulcon			

Course L1202: Structural Dy	namics
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	<ul> <li>mechanical background of dynamics</li> <li>harmonic vibrations, damped and undamped free and forced vibrations</li> <li>frequency and time domain</li> <li>modelling aspects</li> <li>principle of d'Alembert</li> <li>systems with multiple degrees of freedom</li> <li>consistent and lumped mass matrices</li> <li>finite elements for dynamics problems</li> <li>impact problems</li> <li>eigenvalue problems and modal analysis</li> <li>direct time integration schemes, transient analyses</li> </ul>
Literature	<ul> <li>Vorlesungsmanuskript</li> <li>Clough, R.W., Penzien, J.: Dynamics of Structures. 2. Aufl., McGraw-Hill, New York, 1993.</li> </ul>

Course L1203: Structural Dy	ourse L1203: Structural Dynamics		
Тур	Recitation Section (large)		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Jürgen Priebe
Language	DE
Cycle	SoSe
Content	<ul> <li>basics of fatigue stress and fatigue resistance and determination of fatigue strength,</li> </ul>
	determination and use of S-N-curves and classification of notch effects,
	set up of determination of fatigue strength under dynamic load using the accumulation formula by Palmgren-Miner,
	<ul> <li>set up of determination of fatigue strength in different examples,</li> </ul>
	<ul> <li>basics of construction and design regarding the problem of material fatigue,</li> </ul>
	basics of linear elastic fracture mechanics under static and dynamic load,
	determination of lifetime of steel construction based on linear elastic fracture mechanics in different examples.
Literature	Seeßelberg, C.; Kranbahnen - Bemessung und konstruktive Gestaltung; 3. Auflage; Bauwerk-Verlag; Berlin 2009
	• Kuhlmann, Dürr, Günther; Kranbahnen und Betriebsfestigkeit; in Stahlbau Kalender 2003; Verlag Ernst & Sohn; Berlin 200
	Deutscher Stahlbau-Verband (Hrsg.); Stahlbau Handbuch Band 1 Teil B; 3. Auflage; Stahlbau-Verlagsgesellschaft; Köln 19
	Petersen, C.; Stahlbau; 3. überarb. und erw. Auflage; Vieweg-Verlag; Braunschweig 1993
	<ul> <li>DIN V ENV 1993-1-1: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 1-1: Allgemeine Bemessungsre Bemessungsregeln für den Hochbau; 1993</li> </ul>
	• DIN V ENV 1993-6: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 6: Kranbahnen; 2001
	• DIN-Fachbericht 126. Richtlinie zur Anwendung von DIN V ENV 1993-6; Nationales Anwendungsdokument (NAD); Berlin 20

Course L0565: Fracture mechanics and fatigue in steel structures	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Jürgen Priebe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modfle		Lecture	1	1
Groundwater Modeling using Modfle		Recitation Section (small)	2	2 3
Modeling of Water Supply Network		Project-/problem-based Learning	2	3
Module Responsible	•			
Admission Requirements Recommended Previous				
Kecommended Previous Knowledge	Groundwater			
Knowledge	groundwater hydraulics and transport of substan	ces		
	Pipe Systems			
	Knowledge on urban water infrastructures, in	particular drinking water systemsand u	ırban drainag	e systems includir
	special structures		5	
	Hydraulics of drinking water supply systems and	sewer systems		
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	The students are able to describe the modelling of grou	ndwater flow and transport as well as urb	an water infra	astructures. They c
	carry out systems analyses and can detect technical a	nd conceptual weak points within the sys	tems in case s	studies. Besides th
	are able to analyse interdependencies of hydraulic and	toxic phenomena in soil and water.		
Skills	The students are able to construct and apply scientific	groundwater models indipendently. The	y can work o	n different scenario
	and can compare or assess different solutions for existing problems by application of selected software products. The students ar			
	able to use different software solutions (e.g. EPANET, E	PA-SWMM).		
Personal Competence				
	Wird nicht vermittelt.			
Autonomy	Wird nicht vermittelt.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
Examination				
	30 min			
scale				
-	Civil Engineering: Specialisation Structural Engineering			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineer			
	Civil Engineering: Specialisation Coastal Engineering: E Civil Engineering: Specialisation Water and Traffic: Elec			
	Civil Engineering: Specialisation Water and Trainc: Elec Civil Engineering: Specialisation Computational Enginee			
	Water and Environmental Engineering: Specialisation E			
	Water and Environmental Engineering: Specialisation C			
	Water and Environmental Engineering: Specialisation W			

Course L0543: Groundwater	Course L0543: Groundwater Modeling using Modflow		
Тур	Lecture		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Sonja Götz		
Language	DE/EN		
Cycle	SoSe		
Content	Introduction and application of the groundwater model MODFLOW (PMWIN); theoretical backround of the modell, students do work		
	with the model PMWIN for practical case studies.		
Literature	MODFLOW-Handbuch		
	Chiang, Wen Hsien: PMWIN		

Course L0544: Groundwater	urse L0544: Groundwater Modeling using Modflow		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Sonja Götz		
Language	DE/EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0875: Modeling of Water Supply Network		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Klaus Johannsen	
Language	DE	
Cycle	SoSe	
Content		
Literature	Mutschmann/Stimmelmayr: Taschenbuch der Wasserversorgung, 16. Auflage. Springer Vieweg - Verlag. Wiesbaden 2014.	

Courses					
Title		Тур		Hrs/wk	СР
Applied Surface Hydrology (L0289)		Lecture		2	2
Applied Surface Hydrology (L1412)			oblem-based Learning	1	2
nteraction Water - Environment in		Project-/pr	oblem-based Learning	1	2
Module Responsible	Prof. Peter Fröhle				
Admission Requirements	None				
<b>Recommended Previous</b>	Fundamentals of Hydromechanics an	d Hydraulic Engineering: Hydraulic En	gineering I and Hydra	ulic Engineerii	ng II
Knowledge					
Educational Objectives	After taking part successfully, studen	ts have reached the following learning	g results		
Professional Competence					
Knowledge	The students are able to define the	pasic concepts of hydrology and wate	er management. They	are able to d	lescribe and qua
	the relevant processes of the hydrological	gical water cycle. Besides, the stude	nts know the main asp	ects of rainfa	ll-run-off-models
	are able to theoretically derive estab	ished reservoir / storage models and	a unit-hydrograph.		
<i></i>					
Skills	The students are able to use the basic hydrological concepts and approaches and are able to theoretically derive establisher reservoir / storage models or a unit-hydrograph as the basis for rainfall-run-off-models. The student are able to explain the bas				
	-				
		ogical and hydrodynamic values in n			
	assess these measurements. Further	more, they are able to apply a hydrolo	ogical model to basic h	iydrological pi	roblems.
Personal Competence					
Social Competence	The students are able to deploy their	gained knowledge in applied problem	ns of the hydrology and	d water mana	gement. Addition
	they will be able to work in team with	engineers of other disciplines.			
Autonomy	The students will be able to independ	ently extend their knowledge and app	oly it to new problems		
Workload in Hours	Independent Study Time 124, Study	Time in Lecture 56			
Credit points	6				
	None				
Course achievement	Written exam				
Course achievement Examination	Whiteh exam				
Examination	The duration of the examination is 90	min. The examination includes tasks	with respect to the ge	eneral underst	anding of the lec
Examination Examination duration and		min. The examination includes tasks	with respect to the ge	eneral underst	anding of the lec
Examination Examination duration and scale	The duration of the examination is 90			eneral underst	anding of the lec
Examination Examination duration and scale Assignment for the	The duration of the examination is 90 contents and calculations tasks.	putational Engineering: Elective Comp		eneral underst	anding of the lec
Examination Examination duration and scale Assignment for the	The duration of the examination is 90 contents and calculations tasks. Civil Engineering: Specialisation Com	putational Engineering: Elective Comp er and Traffic: Compulsory		eneral underst	anding of the lec
Examination Examination duration and scale Assignment for the	The duration of the examination is 90 contents and calculations tasks. Civil Engineering: Specialisation Com Civil Engineering: Specialisation Wate Environmental Engineering: Core Qua	putational Engineering: Elective Comp er and Traffic: Compulsory	bulsory		anding of the lec
Examination Examination duration and scale Assignment for the	The duration of the examination is 90 contents and calculations tasks. Civil Engineering: Specialisation Com Civil Engineering: Specialisation Wate Environmental Engineering: Core Qua Joint European Master in Environmen	putational Engineering: Elective Comp er and Traffic: Compulsory Ilification: Elective Compulsory	oulsory Core Qualification: Co		anding of the lec
Examination Examination duration and scale Assignment for the	The duration of the examination is 90 contents and calculations tasks. Civil Engineering: Specialisation Com Civil Engineering: Specialisation Watt Environmental Engineering: Core Qua Joint European Master in Environmen Water and Environmental Engineerin	putational Engineering: Elective Comp er and Traffic: Compulsory Ilification: Elective Compulsory :al Studies - Cities and Sustainability:	Core Qualification: Corulation		anding of the lec

Course L0289: Applied Surfa	Course L0289: Applied Surface Hydrology		
Тур	Lecture		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Peter Fröhle		
Language	DE/EN		
Cycle	SoSe		
Content	<ul> <li>Basics of hydrology:</li> <li>Hydrological cycle</li> <li>Data acquisition</li> <li>Data analyses and statistical assessment</li> <li>Statistics of extremes</li> </ul>		
	<ul> <li>Regionalization methods for hydrological values</li> <li>Rainfall-run-off modelling on the basis of a unit hydrograph conceps</li> <li>Application of rainfall-run-off models on the basis of Kalypso-Hydrology which is an OpenSource Software Tool.</li> </ul>		
Literature	http://de.wikipedia.org/wiki/Kalypso_(Software) http://kalypso.bjoernsen.de/ http://sourceforge.net/projects/kalypso/		

Course L1412: Applied Surfa	irse L1412: Applied Surface Hydrology		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
CP	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	DE/EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0295: Interaction W	ourse L0295: Interaction Water - Environment in Fluvial Areas		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	DE/EN		
Cycle	SoSe		
Content	A problem based learning course. The problem will be solved by the students more or less self-contained. The topics will be introduced and elaborated over the semester.		
Literature	-		

Courses					
Title		Тур	Hrs/wk	СР	
Design of Prestressed Structures a	nd Concreet Bridges (L0603)	Lecture	3	4	
Design of Prestressed Structures a	nd Concreet Bridges (L0604)	Recitation Section (large)	2	2	
Module Responsible	NN				
Admission Requirements	None				
<b>Recommended Previous</b>	Detailed knowledge on the design of concrete structures.				
Knowledge	Madulaa, Dainfanaad Cananata Churchunaa I	U. Chrystered Analysis I. U. Mashaning I. U. Canar			
	Modules: Reinforced Concrete Structures I+II, Structural Analysis I+II, Mechanics I+II, Concrete Structures				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results			
Professional Competence					
Knowledge	The students know the main bridge types	s, their applications and the various loads. They	can explain the b	asic design meth	
	They can explain the design of a prestressed bridge.				
<i>CL 11</i>					
SKIIIS	The students are able to design reinforced	f or prestressed concrete bridges.			
Personal Competence					
Social Competence	The students can design in teamwork a rea	al concrete bridge.			
4	The shudents are able to design a super-				
Αυτοποτηγ	The students are able to design a prestres	sed concrete bridge and discuss the problems and	results with othe	r students.	
Workload in Hours	Independent Study Time 110, Study Time	in Lecture 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	180 minutes				
scale					
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechni	ical Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Er	ngineering: Elective Compulsory			
	Civil Engineering: Specialisation Computat	ional Engineering: Elective Compulsory			
	International Management and Engineering				

Course L0603: Design of Pre	stressed Structures and Concreet Bridges
Тур	Lecture
Hrs/wk	
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	NN
Language	DE
Cycle	SoSe
Content	prestressed structures
	<ul> <li>basis of prestressed structures, field of application</li> <li>differences between reinforced and prestressed concrete structures</li> <li>history of prestressing</li> <li>construction materials: concrete, tendons, ducts, anchorage systems</li> <li>construction: prestressing methods</li> <li>prestressing forces and member forces (friction, elongation)</li> <li>tendon layout</li> <li>time dependant prestressing losses</li> <li>design of prestressed structures</li> <li>design of anchorage region</li> <li>non-bonded prestressing</li> <li>prestressed flat slabs</li> </ul>
	Concrete bridges <ul> <li>history of bridges</li> <li>design of bridges</li> <li>loads on bridges</li> <li>loads on bridges</li> <li>member forces for slab, T-beam, hollow box, frame and arch bridges</li> <li>precast bridges - precast segmental bridges</li> <li>bearings</li> <li>abutments, columns</li> <li>construction methods</li> <li>damages - checking of bridges</li> </ul>
Literature	<ul> <li>Vorlesungsumdruckim STUDiP</li> <li>Rombach, G. (2003): Spannbetonbau. Ernst &amp; Sohn, Berlin</li> <li>Wicke, M. (2002): Anwendung des Spannbetons. Betonkalender 2002, Teil II, S. 113-180, Verlag Ernst &amp; Sohn, Berlin</li> <li>Leonhardt, F. (1980): Vorlesungen über Massivbau. Teil 5: Spannbeton. Berlin</li> <li>Mehlhorn, G. (2007): Handbuch Brücken, Springer Verlag</li> <li>Schäfer, H.; Kaufeld, K. (1997): Massivbrücken. Betonkalender Teil II, S. 443ff, Ernst &amp; Sohn, Berlin</li> <li>Menn, Ch. (1986): Stahlbetonbrücken. Springer Verlag, Wien</li> </ul>

Course L0604: Design of Pre	ourse L0604: Design of Prestressed Structures and Concreet Bridges		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	NN		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

	lechanics and -Dynamics			
Courses				
Title		Тур	Hrs/wk	СР
Soil Mechanics - Selected Topics (L	0374)	Lecture	2	2
Soil Dynamics (L0452)		Lecture	2	2
Experimental Researches in Geote	chnics (L0706)	Practical Course	2	2
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
<b>Recommended Previous</b>	Modules: Mathematics I-III, Mechanics I-II, Geotechnic	s l		
Knowledge	Courses: Soil laboratory course, (Applied structural dy	mamics)		
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
	Students will be able to,			
-	<ul> <li>describe ways propagation in the ground under</li> </ul>	r dupomic ovcitation and define the	relevant parameters	
	<ul> <li>describe wave propagation in the ground unde</li> <li>to measure vibrations and to interpret the data</li> </ul>			
	<ul> <li>justify when elastodynamic methods are suffici</li> </ul>			
	<ul> <li>to reproduce the collapse theorems of plasticit</li> </ul>			account,
	<ul> <li>describe the viscous behavior of cohesive so</li> </ul>		or creen deformation	and rate-depende
	shear strengths	is and computationally account it		and rate-depende
	<ul> <li>as well as to determine the effect of partial sat</li> </ul>	uration on the seepage flow and the	e shear strength.	
Skille	After the successful completion of the module the stu	dents should be able to:		
SKIIIS	Arter the successful completion of the module the stu			
	<ul> <li>to derive and apply the basic equation of a sim</li> </ul>			
	<ul> <li>to understand the wave propagation in the soil</li> </ul>			
	<ul> <li>to know the essential laboratory and field tests</li> </ul>		eristics and to evaluat	e them,
	<ul> <li>to design machine foundations to dynamic load</li> </ul>			
	<ul> <li>to measure shocks to perform vibration forecast</li> </ul>			
	<ul> <li>to evaluate shocks in terms of their effect on p</li> </ul>	eople and buildings,		
	<ul> <li>to evaluate possibilities of isolation,</li> </ul>			
	to understand mechanisms that cause earthqu			de and intensity,
	<ul> <li>to know methods to determine axial pile capace</li> </ul>			
	<ul> <li>to know the mechanisms that lead to a deform mathematically,</li> </ul>	lation accumulation due to cyclic ic	ading and to estimate	e these deformatio
	<ul> <li>to distinguish the area of application of the me</li> </ul>	thod of elastodynamics and plastor	lynamics	
	<ul> <li>to detect the undrained shear strength as a fur</li> </ul>			
	<ul> <li>to capture the visous behaviour of cohesive so</li> </ul>			ent shear strength
	calculations,			ene shear serengen
	<ul> <li>to consider the impact of the partly saturated of</li> </ul>	of a seepage and shear strength.		
		1 3 3		
Personal Competence				
Social Competence	Students will be able to work in teams to achieve re	suits on measurement and experir	mental principles and	present their resu
	together at the end of the semester.			
Autonomy	Students are able to assess their own strengths and v	veaknesses and organize their time	and learning manage	ment based on this
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	ļ		
Credit points	6			
Course achievement		scription		
	Yes None Subject theoretical and practical work			
Examination	Written exam			
Examination duration and	135 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering	g: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Enginee	ering: Compulsory		
	Civil Engineering: Specialisation Coastal Engineering:	Elective Compulsory		
	Civil Engineering: Specialisation Computational Engin	eering: Elective Compulsory		

Course L0452: Soil Dynamics				
Тур	Lecture			
Hrs/wk				
СР				
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Anne Hagemann			
Language	DE			
Cycle	SoSe			
Content	mass-spring-damper systems,			
	• wave propagation in soils,			
	• dynamic soil parameters,			
	• Determination of dynamic soil parameters,			
	• machine foundations,			
	in-situ measurement of ground motion, ground motion prediction, evaluation of ground motion,			
	ground motion shielding,			
	ntroduction into earthquake engineering,			
	dynamic pile tests,			
	• cyclic accumulation,			
	• plastodynamics			
Literature	<ul> <li>Das B.M.: Fundamentals of Soil Dynamics, Elsevier</li> <li>Empfehlungen des Arbeitskreises Baugrunddynamik. Hrsg. Deutsche Gesellschaft für Geotechnik (DGGT)</li> <li>Haupt W.: Bodendynamik. Vieweg und Teubner</li> <li>Meskouris K. und Hinzen KG.: Bauwerke und Erdbeben. Vieweg Verlag</li> <li>Studer J.A., Koller M.G. und Laue J.: Bodendynamik, Springer Verlag</li> </ul>			

Course L0706: Experimental	Researches in Geotechnics
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Hans Mathäus Stanford, Göta Bürkner
Language	DE
Cycle	SoSe
Content	The students are supposed to:
	<ul> <li>become acquainted with geotechnical model tests, field tests and laboratory tests as well as corresponding measurement techniques. These compromise amongst others inclinometer measurements and geophone measurements as well as high-grade laboratory tests on the stress-strain relationship of soil specimens, e. g. triaxial tests, simple shear tests and resonant column tests.</li> <li>gain insight into current soil mechanical research.</li> <li>plan, coordinate, perform and evaluate soil mechanical tests in a team.</li> <li>discuss, reflect, review and present the obtained results in a group.</li> </ul> An important learning target is the introduction to scientific work for students who plan a scientific career, and for those who will work in practice with the responsibility to order corresponding tests and evaluate the results. The practical laboratory work is based on annualy changing problems, which are however related to the experience and results of the preceding year's course group.
Literature	- Grabe, J. (2004): Bodenmechanik und Grundbau, Band 3 der Veröffentlichungsreihe des Instituts für Geotechnik und Baubetrieb, Technische Universität Hamburg-Harburg.
	- Kolymbas, D. (2007): Geotechnik - Bodenmechanik, Grundbau und Tunnelbau. 2., korrigierte und ergänzte Auflage, Springer Verlag.
	<ul> <li>Normen zu geotechnischen Versuchsgeräten und Versuchsverfahren:</li> <li>DIN 18135:2012-04: Baugrund, Untersuchung von Bodenproben -</li> <li>Eindimensionaler Kompressionsversuch, Deutsches Institut für</li> <li>Normung, e. V.</li> </ul>
	- DIN 18137-2:2011-04: Baugrund, Untersuchung von Bodenproben - Bestimmung der Scherfestigkeit - Teil 2: Triaxialversuch, Deutsches Institut für Normung e. V.

Module M0854: Mathe	ematics IV			
Courses				
Title		True	Han hule	CD
	icrophial Equations) (11042)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 1
	Differential Equations 2 (Partial Differential Equations) (L1043) Differential Equations 2 (Partial Differential Equations) (L1044)		1	1
Differential Equations 2 (Partial Diff	-	Recitation Section (small) Recitation Section (large)	1	1
Complex Functions (L1038)		Lecture	2	1
Complex Functions (L1041)		Recitation Section (small)	1	1
Complex Functions (L1042)		Recitation Section (large)	1	1
Module Responsible	Prof. Marko Lindner			
Admission Requirements	None			
<b>Recommended Previous</b>	Mathematics I - III			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge				
	<ul> <li>Students can name the basic concepts in Mathem</li> </ul>	natics IV. They are able to explain the	m using appropria	ate examples.
	<ul> <li>Students can discuss logical connections between</li> </ul>	n these concepts. They are capable	of illustrating the	ese connections wit
	the help of examples.			
	<ul> <li>They know proof strategies and can reproduce the</li> </ul>	em.		
Skills	. Chudanta ann an dal anchlana in Mathamatica IV			Manager the second
	Students can model problems in Mathematics IV		ed in this course	. Moreover, they are
	capable of solving them by applying established methods.			
	Students are able to discover and verify further lo			
	For a given problem, the students can develop	and execute a suitable approach, a	nd are able to cl	ritically evaluate th
	results.			
Personal Competence				
Social Competence	<ul> <li>Students are able to work together in teams. They</li> </ul>	v are capable to use mathematics as	a common langua	ade.
	<ul> <li>In doing so, they can communicate new concepts</li> </ul>			
	design examples to check and deepen the unders			,,
	5	5		
Autonomy				
	<ul> <li>Students are capable of checking their understar</li> </ul>	nding of complex concepts on their o	wn. They can sp	ecify open question
	precisely and know where to get help in solving the	hem.		
	<ul> <li>Students have developed sufficient persistence f</li> </ul>	to be able to work for longer period	s in a goal-orien	ted manner on har
	problems.			
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112			
Credit points	6			
Course achievement	None			
Examination				
	60 min (Complex Functions) + 60 min (Differential Equal	tions 2)		
scale				
	General Engineering Science (German program, 7 semes	ster): Specialisation Electrical Engine	ring: Compulsor	1
5	General Engineering Science (German program, 7 series General Engineering Science (German program, 7 s		5 1 5	
i onowing curriculd	Compulsory		. Ligineeiiig, I	seus mechatronits
	General Engineering Science (German program, 7 semes	ster): Specialisation Naval Architectur	e: Compulson	
		•		enetical Machania
	General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanica			
	Engineering: Elective Compulsory	ring, Flactive Commuter		
	Civil Engineering: Specialisation Computational Engineer	ring: Elective Compulsory		
	Electrical Engineering: Core Qualification: Compulsory			
	General Engineering Science (English program, 7 semesi		• • •	
	Computer Science in Engineering: Specialisation II. Math			
	Mechanical Engineering: Specialisation Theoretical Mech		ory	
	Mechanical Engineering: Specialisation Mechatronics: Co		ory	
	Mechanical Engineering: Specialisation Mechatronics: Co Mechatronics: Core Qualification: Compulsory		ory	
	Mechanical Engineering: Specialisation Mechatronics: Co	ompulsory		

Course L1043: Differential E	quations 2 (Partial Differential Equations)
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of the theory and numerical treatment of partial differential equations
	<ul> <li>Examples of partial differential equations</li> <li>First order quasilinear differential equations</li> <li>Normal forms of second order differential equations</li> <li>Harmonic functions and maximum principle</li> <li>Maximum principle for the heat equation</li> <li>Wave equation</li> <li>Liouville's formula</li> <li>Special functions</li> <li>Difference methods</li> <li>Finite elements</li> </ul>
Literature	<ul> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>

Course L1044: Differential Equations 2 (Partial Differential Equations)		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1045: Differential Equations 2 (Partial Differential Equations)		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dozenten des Fachbereiches Mathematik der UHH	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1038: Complex Fund	tions
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of complex analysis
	<ul> <li>Functions of one complex variable</li> <li>Complex differentiation</li> <li>Conformal mappings</li> <li>Complex integration</li> <li>Cauchy's integral theorem</li> <li>Cauchy's integral formula</li> <li>Taylor and Laurent series expansion</li> <li>Singularities and residuals</li> <li>Integral transformations: Fourier and Laplace transformation</li> </ul>
Literature	<ul> <li>http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html</li> </ul>

Course L1041: Complex Functions		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Hanna Peywand Kiani	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1042: Complex Fund	ourse L1042: Complex Functions		
Тур	Recitation Section (large)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Dozenten des Fachbereiches Mathematik der UHH		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Гitle		Тур	Hrs/wk	СР
Modeling Processes in Vadose Zone	e (L2735)	Recitation Section (small)	2	2
Vadose Zone Hydrology (L2732)		Lecture	2	2
Vadose Zone Hydrology (L2733)		Recitation Section (large)	2	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge in water and soil			
Knowledge				
_	Comfortable with math and physics, critic	cal thinking, creative problem solving		
	Analytic skills			
	, mary are shares			
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	The students will learn about soil cha	racterization (solid and liquid phase), the ene	rgy state of soil w	vater, the soil wa
	characteristic curve, flow in saturated and unsaturated soil as well as about solute transport in soil			
Skills	Students will work on practical examples modelling transport processes in soil using different quantitative tools includir			
	computer simulations and analytical tools. This will help them to apply knowledge in order to solve problems and tasks.			
Personal Competence				
	The module sime at raising awareness	and anthusiasm for now knowledge related to	water cell and e	nvironmont This
Social competence	The module aims at raising awareness and enthusiasm for new knowledge related to water, soil and environment. This w positively contribute to shape their work and life environment.			
	positively contribute to shape their work a	and me environment.		
Autonomy	The students will be involved in many problem solving exercises. This will contribute toward their willingness to wor			
	independently and responsibly.			
	Independent Study Time 96, Study Time	IN LECTURE 84		
Credit points	6 None			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Report and Presentation			
scale				
-	Civil Engineering: Specialisation Computa			
Following Curricula	Civil Engineering: Specialisation Water an			
	Environmental Engineering: Core Qualific			
	Water and Environmental Engineering: Sp	pecialisation Water: Elective Compulsory		
		pecialisation Environment: Elective Compulsory		

Course L2735: Modeling Processes in Vadose Zone	
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Mohammad Aziz Zarif
Language	EN
Cycle	SoSe
Content	Numerical tools will be introduced and used to quantify flow and transport processes in soil
Literature	NA

## Module Manual M.Sc. "Civil Engineering"

Course L2732: Vadose Zone	Hydrology
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	SoSe
Content	Soil solid phase characterization, Soil liquid phase characterization, The energy state of soil water, Soil Water Characteristic
	Curve, Flow in saturated soil, Flow in unsaturated soil, Solute transport in porous media
Literature	- Environmental Soil Physics, by Daniel Hillel
	- Soil Physics, Sixth Edition, by William A. Jury and Robert Horton
	- Physical Hydrology, Second Edition, by S. Lawrence Dingman
	- Introduction to Physical Hydrology, by Martin R. Hendriks

Course L2733: Vadose Zone	urse L2733: Vadose Zone Hydrology		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Nima Shokri		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses				
Title		Тур	Hrs/wk	СР
Nonlinear Structural Analysis (L0277)		Lecture	3	4
Nonlinear Structural Analysis (L0279)		Recitation Section (small)	1	2
Module Responsible Prof. Alexa	er Düster			
Admission Requirements None				
Recommended Previous Knowledge	Knowledge of partial differential equations is recommended.			
Knowledge				
Educational Objectives After takin	oart successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge Students a	able to			
+ give an	erview of the different nonlinear phen	omena in structural mechanics.		
	mechanical background of nonlinear			
		sis, to identify them in a given situation a	and to explain th	eir mathematical a
mechanica	ackground.			
Skills Students a	able to			
+ model n	linear structural problems.			
+ select fo	given nonlinear structural problem a	suitable computational procedure.		
+ apply fir	element procedures for nonlinear str	uctural analysis.		
+ critically	erify and judge results of nonlinear fin	ite elements.		
+ to transf	their knowledge of nonlinear solution	procedures to new problems.		
Personal Competence				
	Social Competence Students are able to			
	ems in heterogeneous groups. d discuss their results in front of othe	~		
	ccept professional constructive criticis			
i give une				
Autonomy Students a	able to			
	r knowledge by means of exercises a			
	nemselves with the necessary knowled			
+ to transf	m the acquired knowledge to similar p	problems.		
	Study Time 124, Study Time in Lectur	re 56		
Credit points 6				
Course achievement None				
Examination Written ex	1			
Examination duration and 120 min				
scale				
Assignment for the Civil Engin	ring: Specialisation Structural Enginee	ring: Elective Compulsory		
	ring: Specialisation Computational Eng			
		alisation II. Civil Engineering: Elective Com	pulsory	
	ence: Specialisation Modeling: Elective	1 3		
	: Technical Complementary Course: E	1 3		
	: Core Qualification: Elective Compuls			
		ore Qualification: Elective Compulsory		
	cture and Ocean Engineering: Core Q			
Ship and C Theoretica	hore Technology: Core Qualification:	Elective Compulsory		

Course L0277: Nonlinear Str	uctural Analysis
Тур	Lecture
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	WiSe
Content	1. Introduction
	2. Nonlinear phenomena
	3. Mathematical preliminaries
	4. Basic equations of continuum mechanics
	5. Spatial discretization with finite elements
	6. Solution of nonlinear systems of equations
	7. Solution of elastoplastic problems
	8. Stability problems
	9. Contact problems
Literature	[1] Alexander Düster, Nonlinear Structrual Analysis, Lecture Notes, Technische Universität Hamburg-Harburg, 2014.
	[2] Peter Wriggers, Nonlinear Finite Element Methods, Springer 2008.
	[3] Peter Wriggers, Nichtlineare Finite-Elemente-Methoden, Springer 2001.
	[4] Javier Bonet and Richard D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge University Press,
	2008.

Course L0279: Nonlinear Str	Course L0279: Nonlinear Structural Analysis	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Alexander Düster	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses						
Title			Tr	n	Hrs/wk	СР
Applied Tunnel Constructions (L24)	)7)		Ty	P cture	2	3
ntroduction to tunnel construction				ture	1	2
ntroduction to tunnel construction	(L1811)		Ree	citation Section (large)	1	1
Module Responsible	Prof. Jürgen Grabe					
Admission Requirements	None					
<b>Recommended Previous</b>	Modules from Bachelo	or studies Civil and env	ironmental engineering:			
Knowledge	Geotechnics I-II	I				
Educational Objectives	After taking part succe	essfully, students have	e reached the following le	earning results		
Professional Competence						
Knowledge	Knowledge of different tunnel construction types as well as special methods and techniques of subsoil construction.					
Skills	Basic knowledge of tunnel design as well as practical skills in structural tunnel analysis.					
Personal Competence						
Social Competence	Capacity for teamwork concerning project management and design of tunnels.					
Autonomy	Promotion of independent and creative work flow in the framework of a design exercise.					
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56					
Credit points						
Course achievement	Compulsory Bonus	Form	Description			
	No 5 %	Excercises				
Examination	Written exam					
Examination duration and	120 minutes					
scale						
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory					
Following Curricula	Civil Engineering: Spe	cialisation Geotechnica	al Engineering: Compuls	ory		
	Civil Engineering: Spe	cialisation Coastal Eng	ineering: Compulsory			
	Civil Engineering: Spe	cialisation Water and T	Fraffic: Elective Compuls	ory		
	Civil Engineering: Spe	cialisation Computatio	nal Engineering: Elective	e Compulsory		
	civil Eligilicerilig. Spe		5 5	1 2		

Course L2407: Applied Tunnel Constructions	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe, Tim Babendererde
Language	DE
Cycle	WiSe
Content	
Literature	

Course L0707: Introduction t	o tunnel construction	
Тур	Lecture	
Hrs/wk		
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Dr. Julian Bubel	
Language	DE	
Cycle	WiSe	
Content	<ul> <li>Definitions</li> <li>Historical development in tunneling</li> <li>Geology for tunneling</li> <li>Hard rock tunneling (construction composite and machines)</li> <li>Tunnelung in temporarly stable soil with conventional construction methods</li> <li>Tunneling in soft soils (form of supports, shield types, compressed air application)</li> </ul>	
	<ul> <li>Pipe jacking</li> <li>Tunnel Lining, tunnel supporting structures</li> <li>Calculation approaches for supporting structures in shield-driven tunnels</li> <li>Surveying for tunneling</li> <li>Safety requirements</li> <li>Construction Contract</li> <li>Literature and sources</li> </ul>	
Literature	Vorlesung/Übung s. www.tu-harburg.de/gbt	

Course L1811: Introduction to tunnel construction	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Julian Bubel
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Courses				
Title		Тур	Hrs/wk	СР
Scientific Working in Computationa	l Engineering (L2764)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge in scientific writing. String interest in	topics related to computing in civil engine	ering.	
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Personal Competence Social Competence	course instructors and in collaboration with each other thinking, being able to accurately plan, implement ar will be conducted throughout the semester, which will this course, a scientific paper will be developed based based on the project conducted within this course. If scientific publications are further key activities. The students will be capable (i) of solving a scientific effectively in the form of a paper, and (iii) of sharing the The students will be able to work in a multidisciplinary The students will be able to extend their knowledge ar	Id analyze scientific projects, such as pro contribute to the grade. Since scientific wu , which is a prerequisite for the final exan project meetings in small groups, present problem following a scientific methodolo leir work in a presentation. team and develop communication skills ne	spective mash riting is of par- nination. The ations, and c gy, (ii) of doc ecessary for p	ter theses. A proju- ticular importance paper will be writt ritical discussions umenting their wo roblem solving.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	2		
Credit points		-		
	None			
Examination	Written elaboration			
Examination duration and	10 pages of work with 15-minute oral presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Ele	tive Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Enginee	ing: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: I	lective Compulsory		
	Civil Engineering: Specialisation Structural Engineering	: Elective Compulsory		
	Civil Engineering: Specialisation Computational Engine	ering: Elective Compulsory		
	Computer Science: Specialisation II: Intelligence Engin	eering: Elective Compulsory		

Course L2764: Scientific Wor	rking in Computational Engineering
Тур	Project-/problem-based Learning
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	WiSe/SoSe
Content	In the course, a scientific problem of practical relevance will first be defined, taking into account the interests of the students participating in the course. The scientific problem will then systematically be solved within the framework of a comprehensive project. The principles of scientific working will be taught based on the scientific problem defined previously. As an integral part of scientific working, fundamentals of scientific writing will be presented and applied to a scientific paper to be written during the course. Topics related to scientific writing include structuring in scientific writing (structuring the abstract, the introduction, the main part, the summary and conclusions, and the acknowledgments and references) and recommendations on effective scientific writing (principles of composition, use of English in scientific writing, useful tips, creating figures, writing in mathematics, referencing, and formal email correspondence). A final paper and a final presentation will be assembled by the students.
Literature	Smarsly, K. & Dragos, K., 2019. Scientific Writing in Engineering. Tredition, Hamburg, Germany.

Courses				
Title		Тур	Hrs/wk	СР
Modern discretization methods in structural mechanics (L3043)		Lecture	2	3
Modern discretization methods in s	tructural mechanics (L3044)	Recitation Section (small)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	<ul><li>Finite Element Methods</li><li>Flächentragwerke</li></ul>			
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, students can express the basic aspects of modern discretization methods in structur mechanics.			
Skills	After successful completion of this module, the students will be able to use and further improve modern discretization methods for problems in structural mechanics.			
Personal Competence				
Social Competence	Students can			
	<ul> <li>participate in subject-specific and interdis</li> </ul>	ciplinary discussions,		
	<ul> <li>defend their own work results in front of others</li> </ul>			
	<ul> <li>promote the scientific development of col</li> </ul>	leagues		
	• Furthermore, they can give and accept pr	ofessional constructive criticism		
Autonomy	Students are able to gain knowledge of the subject area from given and other sources and apply it to new problems. Furthermo			
	they are able to structure the solution process for problems in the area of modern discretization methods.			
Workload in Hours	Independent Study Time 124, Study Time in Lec	ture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Enginee	ring: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Er	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Engin	eering: Elective Compulsory		
	Civil Engineering: Specialisation Computational I	Engineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialisati	on Simulation Technology: Elective Compulso	ry	

ourse L3043: Modern discretization methods in structural mechanics		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	EN	
Cycle	WiSe	
Content	<ul> <li>The course covers variational formulations, various locking phenomena and alternative formulations for finite elements and modern discretization schemes in the context of structural mechanics, like isogeometric analysis.</li> <li>variational formulation of finite elements, mixed variational principles</li> <li>geometrical and material locking effects in structural and solid mechanics</li> <li>hybrid-mixed and enhanced assumed strain finite element formulations, reduced integration and stabilization, DSG method, u-p formulations</li> <li>patch test, stability, convergence</li> <li>linear and non-linear analyses</li> <li>introduction to isogeometric analysis</li> <li>isogeometric beam, plate and shell formulations</li> <li>locking effects and their avoidance in modern, smooth discretization schemes, like isogeometric analysis</li> </ul>	
Literature	<ul> <li>lecture notes and selected scientific papers</li> <li>O.C. Zienkiewicz, R.L. Taylor, and J.Z. Zhu: Finite Element Method: Its Basis and Fundamentals. Elsevier, 2013.</li> <li>J. Austin Cottrell, Thomas J. R Hughes, Yuri Bazilevs: Isogeometric Analysis: Toward Integration of CAD and FEA. Wiley, 2009.</li> </ul>	

Course L3044: Modern discre	ourse L3044: Modern discretization methods in structural mechanics		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses	
Title	Typ Hrs/wk CP
Module Responsible	Dozenten des SD B
Admission Requirements	None
<b>Recommended Previous</b>	Subjects of the computational engineering specialisation.
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to demonstrate their detailed knowledge in the field of computational engineering engineering. They can exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions science and society. The students can develop solving strategies and approaches for fundamental and practical problems in computational engineering.
	They may apply theory based procedures and integrate safety-related, ecological, ethical, and economic view points of scien and society. Scientific work techniques that are used can be described and critically reviewed.
Skills	The students are able to independently select methods for the project work and to justify this choice. They can explain how the methods relate to the field of work and how the context of application has to be adjusted. General findings and furth developments may essentially be outlined.
Personal Competence	
Social Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems f the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to the colleagues.
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the give deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedbac from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0
Credit points	6
Course achievement	None
Examination	Study work
Examination duration and	see FSPO
scale	
Assignment for the	Civil Engineering: Specialisation Computational Engineering: Compulsory
Following Curricula	

## Module M0969: Selected Topics in Civil Engineering

Courses				
Title		Тур	Hrs/wk	СР
Design of Composite Bridges (L3092)		Integrated Lecture	2	3
Analysis of Offshore Structures (L1867)		Lecture	1	1
Energy Geotechnics (L3227)		Lecture	3	3
Solid Matter Process Technology fo	r Biomass (L0052)	Lecture	2	3
Forum I - Geotechnics and Constru	ction Management (L1634)	Seminar	1	1
Forum II - Geotechnics and Constru	ction Management (L1635)	Seminar	1	1
Timber Structures (L1151)		Seminar	2	2
Innovative Timber Construction (L2	666)	Lecture	2	4
Glass Structures (L1152)		Lecture	2	2
Glass Structures (L1447)		Recitation Section (large)	1	1
Sustainable landfill design and ope	ration (L3270)	Integrated Lecture	3	3
Special Topics in Steel Design (L30	91)	Integrated Lecture	2	3
Special topics of civil engineering 1			1	1
Special topics of civil engineering 2	2 LP (L2379)		2	2
Special topics of civil engineering 3	3 LP (L2380)		3	3
Structural Design (L2789)		Seminar	2	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge				
	<ul> <li>Students are able to find their way through se</li> </ul>			
	<ul> <li>Students are able to explain basic models and</li> </ul>	l procedures in selected special areas of	civil and structure	al engineering.
	<ul> <li>Students are able to interrelate scientific and the scientific and the scientific and the science of the science</li></ul>	technical knowledge.		
Skills	• Students are able to apply basic methods in se	elected areas of civil and structural engin	eering.	
Personal Competence				
Social Competence				
Autonomy				
	<ul> <li>Students can chose independently, in which the courses.</li> </ul>	fields they want to deepen their knowled	dge and skills th	ough the election o
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the	Civil Engineering: Specialisation Structural Engineering	ng: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	ering: Elective Compulsory		
<b>C</b>	Civil Engineering: Specialisation Coastal Engineering			
	Civil Engineering: Specialisation Water and Traffic: El			
	Civil Engineering: Specialisation Water and Tranc. En			
	civin Engineering. Specialisation Computational Engli	icening. Liective compuisory		

Course L3092: Design of Composite Bridges	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	
Literature	

## Module Manual M.Sc. "Civil Engineering"

Course L1867: Analysis of Of	
Тур	Lecture
CP Workload in Hours	1 Independent Study Time 16, Study Time in Lecture 14
Examination Form	
Examination duration and	
scale	
Lecturer	Dr. Said Fawad Mohammadi
Language	DE/EN
Cycle	SoSe
Content	Topic 1: Types of Offshore Structures, Fixed and floating structures for Oil & Gas and Offshore Wind industry
	Topic 2: Wave Forces, Morisons equation
	Topic 3: Irregular Seastates, Power spectrum and application of FFT
	Topic 4: Additional Environmental Forces, wind spectra, current forces
	Topic 5: Linear-Time-Invariant Systems, response of an LTI-system in frequency domain
	Topic 6: Tubular Welded Connections, stress concentration factors, weld geometry
	Topic 7: Introduction to Fracture Mechanics, criteria for fracture initiation and crack growth
	Topic 8: Time and Frequency Domain Fatigue Analyses, rainflow counting, application of LTI-systems for frequency domain fatigue
	Topic 9: Offshore Installation and Exam, installation of structures, pile driving, pipe laying techniques
Literature	Chakrabarti, Handbook of Offshore Engineering, 2005
	Sarpkaya, Wave Forces on Offshore Structures, 2010
	Faltinsen, Sea Loads on Ships and Offshore Structures, 1998
	Sorensen, Basic Coastal Engineering, 2006
	Dowling, Mechanical Behavior of Materials, 2007
	Haibach, Betriebsfestigkeit, 2006
	Marshall, Design of Welded Tubular Connections, 1992
	Newland, Random vibrations, spectral and wavelet analysis, 1993

Course L3227: Energy Geotechnics		
Тур	Lecture	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Schriftliche Ausarbeitung (laut FPrO)	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Pauline Kaminski	
Language	DE/EN	
Cycle	WiSe	
Content	Energy geotechnics is a young field in geotechnical engineering with the aim of developing sustainable geotechnical solutions for future-oriented issues relating to the production, transport, operation, decommissioning, and waste utilisation of various energy sources. Examples of possible fields of activity in energy geotechnics include geothermal energy and thermally activated foundation components, foundations for onshore and offshore wind turbines, the decommissioning of mining facilities and the handling of waste products from fossil fuels such as tailings and the geological storage of CO2. Relevant soil mechanical processes in these applications include the thermo-hydro-mechanically coupled behaviour of soils, multiphase flow in porous media and partially saturated soils. The lecture gives an overview of various aspects of energy geotechnics and provides in-depth knowledge of the associated soil mechanical processes. In addition, CO2-scarce geotechnical applications are discussed and emission estimates as well as the optimisation of geotechnical structures according to sustainability aspects are addressed.	
Literature		

Course L0052: Solid Matter F	Process Technology for Biomass
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Prof. Werner Sitzmann
Language	DE
Cycle	SoSe
Content	The industrial application of unit operations as part of process engineering is explained by actual examples of solid biomass
	processes. Size reduction, transportation and dosing, drying and agglomeration of renewable resources are described as important
	unit operations when producing solid fuels and bioethanol, producing and refining edible oils, when making Btl - and WPC -
	products. Aspects of explosion protection and plant design complete the lecture.
Literature	Kaltschmitt M., Hartmann H. (Hrsg.): Energie aus Bioamsse, Springer Verlag, 2001, ISBN 3-540-64853-4
	Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz, Schriftenreihe Nachwachsende Rohstoffe,
	Fachagentur Nachwachsende Rohstoffe e.V. www.nachwachsende-rohstoffe.de
	Bockisch M.: Nahrungsfette und -öle, Ulmer Verlag, 1993, ISBN 380000158175

Course L1634: Forum I - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1635: Forum II - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1151: Timber Structures	
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and	90 min
scale	
Lecturer	Prof. Torsten Faber
Language	DE
Cycle	WiSe
Content	
Literature	

Course L2666: Innovative Timber Construction		
Тур	Lecture	
Hrs/wk	2	
CP	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Examination Form	Schriftliche Ausarbeitung	
Examination duration and	45 Minuten	
scale		
Lecturer	Dr. Andreas Meisel	
Language	DE	
Cycle	WiSe	
Content		
Literature	- Blass, J.: "Ingenieurholzbau"	
	- Schickhofer, G.: "BSPhandbuch: Holz-Massivbauweise in Brettsperrholz"	
	- Informationsdienst Holz: div. Merkblätter und Broschüren	
	- Wallner-Novak M.: Brettsperrholz Bemessung, Band 1 und 2	
	- Gerner M.: "Fachwerk: Entwicklung, Instandsetzung, Neubau"	
	- Meisel, A.: "Historische Dachwerke: Beurteilung, realitätsnahe statische Analyse und Instandsetzung"	
	- Kempe K.: "Dokumentation Holzschädlinge"	
	- Huckfeldt T.: "Hausfäule- und Bauholzpilze"	

Course L1152: Glass Structures		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and		
scale		
Lecturer	Marvin Matzik	
Language	DE	
Cycle	WiSe	
Content	Glass structures	
	<ul> <li>Introduction of the material glass (production, refinement, material characteristic)</li> <li>design of facades</li> </ul>	
	- facade types	
	- static calculation of glazing	
	- static calculation of facades	
	- load bearing behavior of glazing (plate or membrane stiffness)	
	- vertical / horizontal glazing with safety-related requirements	
	- glass structures	
	- fire safety of glass facades	
	- construction physics of facades and glazing	
Literature		

Course L1447: Glass Structures	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L3270: Sustainable la	andfill design and operation
Тур	Integrated Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Dr. Marco Ritzkowski
Language	EN
Cycle	SoSe
Content	The course introduces the development of modern waste resource management and demonstrates the importance of landfills in the context of recycling processes. Based on international (EU) and national legislation, the current landfill situation is presented and the future significance of landfills will be discussed. A central element of the course deals with the main transformation processes in the landfilled waste, the emission of gases and leachate, the long-term behaviour of landfills as well as aftercare and after-utilisation measures. Further focal points of the course are measures for the sustainable reduction of environmentally and climate-damaging emissions and aspects of landfill technology in an international context.
Literature	<ol> <li>Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105, Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305</li> <li>Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332</li> <li>Solid Waste Landfilling - Concepts, Processes, Technologies. Cossu, R. and Stegmann, R. (Eds.), ISBN: 978-0-12-818336-6</li> <li>PDF (Volltext) über TUB</li> </ol>

Course L3091: Special Topics in Steel Design	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner, Nikolay Lalkovski
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2378: Special topics of civil engineering 1CP		
Тур		
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Examination Form	Fachtheoretisch-fachpraktische Arbeit	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Dozenten des SD B	
Language	DE	
Cycle	WiSe/SoSe	
Content	The course occurs only if required. The content is defined at short notice.	
Literature	Die Literatur wird kurzfristig festgelegt.	

Course L2379: Special topics of civil engineering 2 LP		
Тур		
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Fachtheoretisch-fachpraktische Arbeit	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Dozenten des SD B	
Language	DE	
Cycle	WiSe/SoSe	
Content	The course occurs only if required. The content is defined at short notice.	
Literature	Die Literatur wird kurzfristig festgelegt.	

Course L2380: Special topics of civil engineering 3 LP		
Тур		
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Examination Form	Fachtheoretisch-fachpraktische Arbeit	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Dozenten des SD B	
Language	DE	
Cycle	WiSe/SoSe	
Content	The course occurs only if required. The content is defined at short notice.	
Literature	Die Literatur wird kurzfristig festgelegt.	

Course L2789: Structural Des	sign
Тур	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	20 min
scale	
Lecturer	Dr. Jan Mittelstädt
Language	DE/EN
Cycle	SoSe
Content	
Literature	[1] Structure Systems by Heino Engel, Hantje Cantz, 3rd edition (Feb 2007), ISBN-10: 3775718761
	Form and Force, Designing Efficient, Expressive Structures by Allan, E., Zalewski, W. et al, John Wiley and
	Sons; 1st edition (Sept 2009), ISBN-10: 047017465X
	[2] Peter Rice: An Engineer Imagines, ISBN-10 : 1849944237
	[3] Konrad Wachsmann and the Grapevine Structure by C. Sumi et al., Park Books (Oct 2018), ISBN-10:
	9783038601104
	[4] Manual of Multi-Story Timber Construction by Hermann Kaufmann, Stefan Krotsch, Stefan Winter, DETAIL,
	(June 2018), ISBN-10: 3955533948
	[5] The Art of Structural Design: A Swiss Legacy by B. Billington, Princeton University Art Museum; First Edition
	edition (Mar 2003), ISBN-10: 0300097867
	[6] Structured Lineages: Learning from Japanese Structural Design by G. Nordenson et al, The Museum of
	Modern Art (Jul 2019), ISBN-10: 1633450562
	[7] The Structure: Works of Mahendra Raj by V. Mehta, R. Mehndiretta, A. Huber, Park Books (Oct 2015),
	ISBN-10: 3038600253

	ing and Excavation Law			
Courses				
Title		Тур	Hrs/wk	СР
Construction law BGB and VOB - la		Lecture	2	3
	ction (excavation) practice (L3181)	Lecture	2	3
Module Responsible				
Admission Requirements				
Kecommended Previous Knowledge	Complete modules: Geotechnics I-III			
_	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
-	Students will gain knowledge of			
	<ul> <li>the history of civil engineering law,</li> </ul>			
	<ul> <li>basics of foundation and civil engineerin</li> </ul>	g law,		
	<ul> <li>legal aspects of technical regulations in</li> </ul>	civil engineering (with case studies),		
	<ul> <li>the civil engineering contract,</li> </ul>			
	<ul> <li>the liability of the designer and contract</li> </ul>	or in civil engineering,		
	<ul> <li>the subsoil risk and the system risk,</li> </ul>			
	<ul> <li>the total debt in (civil) engineering law,</li> </ul>			
	<ul> <li>the (construction) conflict, dispute avoid</li> </ul>		ess,	
	the systematics of construction contract	law,		
	the BGB construction contract law,			
	<ul> <li>responsibilities on the construction site,</li> <li>remuneration and contract management</li> </ul>			
	<ul> <li>remuneration and contract management</li> <li>liability for defacts</li> </ul>	-,		
	<ul><li>liability for defects,</li><li>public procurement law</li></ul>			
	<ul> <li>Disturbed construction processes: How r</li> </ul>	nuch money am Lentitled to?		
	<ul> <li>Correct calculation of supplements.</li> </ul>	inden money and enclose to:		
Skille	Students learn to apply legal aspects in planni	ng and construction in a legally balance	ad way Students learn l	now to use legal :
Skiiis	construction management aspects in practice			
	to manage the construction project optimally.	(planning and construction) on the con-	struction site in a targe	
Personal Competence				
Social Competence	Students can work in groups and support each	other in finding solutions.		
Autonomy	Students are able to assess their own strength	and weaknesses and organize their tin	ne and learning manage	ment based on th
Workload in Hours	Independent Study Time 124, Study Time in Le	cture 56		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engine			
Following Curricula		5 5 1 5		
	Civil Engineering: Specialisation Structural Engi	• • •		
	Civil Engineering: Specialisation Water and Tra			
	Civil Engineering: Specialisation Computational	Engineering: Elective Compulsory		

Course L3182: Construction	ourse L3182: Construction law BGB and VOB - law in (excavation) practice		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Günther Schalk		
Language	DE		
Cycle	WiSe		
Content			
Literature	Literatur:		
	- Folienskript (in der Vorlesung erhältlich)		
	- Fuchs/Maurer/Schalk: Handbuch Tiefbaurecht		

Course L3181: Construction	ourse L3181: Construction disputes from construction (excavation) practice	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Ingo Junker	
Language	DE	
Cycle	WiSe	
Content		
Literature		

Module M2025: Finite	element modeling of structure	es		
Courses				
Title		Тур	Hrs/wk	СР
Finite element modeling of structur	es (L3046)	Lecture	2	3
Finite element modeling of structur	es (L3047)	Recitation Section (small)	2	3
Module Responsible	Prof. Bastian Oesterle			
Admission Requirements	None			
Recommended Previous Knowledge	<ul><li>Finite Element Methods</li><li>Thin-walled structures</li></ul>			
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	After successful completion of this module, st	tudents can express the basic aspects of modelli	ng of structures	with finite elements
Skills	After successful completion of this module, the students will be able to model structures with finite elements and to analyse structures using appropriate computational methods.			
Personal Competence				
Social Competence	Students can			
	<ul> <li>participate in subject-specific and inter</li> </ul>	rdisciplinary discussions,		
	defend their own work results in front	of others		
	<ul> <li>promote the scientific development of</li> </ul>	colleagues		
	• Furthermore, they can give and accept	t professional constructive criticism		
Autonomy		ubject area from given and other sources and ap is for problems in the area of finite element mode		
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	written elaboration of a project work (10-15 p	pages)		
scale				
Assignment for the	Civil Engineering: Specialisation Computation	al Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Coastal Engi	neering: Elective Compulsory		
	Civil Engineering: Specialisation Geotechnica	l Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Er	ngineering: Elective Compulsory		
	Theoretical Mechanical Engineering: Specialis	sation Simulation Technology: Elective Compulso	ry	

Course L3046: Finite element modeling of structures		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	EN	
Cycle	WiSe	
Content	<ul> <li>Basic phenomena and aspects of the finite element modelling of structures are discussed. Besides theoretical decription of the phenomena and methods, a strong focus is on the practical use a commercial finite element software within computer-based exercises. The covered topics are: <ul> <li>finite element modeling of trusses/beams/frames, plates subject to in-plane/out-of-plane loading and shells</li> <li>convergence properties of displacements and stresses</li> <li>singularities</li> <li>locking effects</li> <li>critical assessment, interpretation and check of results</li> <li>mixed-dimensional coupling of finite elements</li> <li>geometrically linear and non-linear, and material linear and non-linear analyses</li> <li>stability: bifurcation and snap-through problems</li> <li>dynamic problems, modal analyses</li> </ul> </li> </ul>	
Literature	Vorlesungsmanuskript, Vorlesungsfolien	

Course L3047: Finite elemen	ourse L3047: Finite element modeling of structures		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

## **Specialization Water and Traffic**

Courses					
Title			Тур	Hrs/wk	СР
Applied Tunnel Constructions (L240	07)		Lecture	2	3
Introduction to tunnel construction			Lecture	1	2
Introduction to tunnel construction	(L1811)		Recitation Section (larg	e) 1	1
Module Responsible	Prof. Jürgen Grabe				
Admission Requirements	None				
<b>Recommended Previous</b>	Modules from Bache	elor studies Civil an	d environmental engineering:		
Knowledge	Geotechnics	-11			
Educational Objectives	After taking part suc	ccessfully, students	have reached the following learning results		
Professional Competence					
Knowledge	Knowledge of different tunnel construction types as well as special methods and techniques of subsoil construction.				
Skills	Basic knowledge of tunnel design as well as practical skills in structural tunnel analysis.				
Personal Competence					
Social Competence	Capacity for teamwork concerning project management and design of tunnels.				
Autonomy	Promotion of independent and creative work flow in the framework of a design exercise.				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6				
Course achievement		Form	Description		
	No 5 %	Excercises			
	Written exam				
Examination duration and	120 minutes				
scale					
•			aral Engineering: Elective Compulsory		
Following Curricula			hnical Engineering: Compulsory		
	5 5 1		l Engineering: Compulsory		
			and Traffic: Elective Compulsory		
			itational Engineering: Elective Compulsory		
	International Manag	ement and Enginee	ring: Specialisation II. Civil Engineering: Elective	Compulsory	

Course L2407: Applied Tunnel Constructions		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Jürgen Grabe, Tim Babendererde	
Language	DE	
Cycle	WiSe	
Content		
Literature		

Course L0707: Introduction t	to tunnel construction
Тур	Lecture
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dr. Julian Bubel
Language	DE
Cycle	WiSe
Content	<ul> <li>Definitions</li> <li>Historical development in tunneling</li> <li>Geology for tunneling</li> <li>Hard rock tunneling (construction composite and machines)</li> <li>Tunnelung in temporarly stable soil with conventional construction methods</li> <li>Tunneling in soft soils (form of supports, shield types, compressed air application)</li> <li>Pipe jacking</li> </ul>
	<ul> <li>Tunnel Lining, tunnel supporting structures</li> <li>Calculation approaches for supporting structures in shield-driven tunnels</li> <li>Surveying for tunneling</li> <li>Safety requirements</li> <li>Construction Contract</li> <li>Literature and sources</li> </ul>
Literature	Vorlesung/Übung s. www.tu-harburg.de/gbt

Course L1811: Introduction to tunnel construction		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Julian Bubel	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Examination of Materials, Structura	l Condition and Damages (L0260)	Lecture	3	4
Examination of Materials, Structura	l Condition and Damages (L0261)	Recitation Section (small)	1	2
Module Responsible	Prof. Frank Schmidt-Döhl			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge about building materials or r	naterial science, for example by the mo	dule Building Ma	terials and Buildin
Knowledge	Chemistry.			
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Knowledge	The students are able to describe the rules for t methods for the testing of building material prope testing methods.			
Skills	The students are able to responsibly discover the They are able to chose suitable methods for the the examination of the structural conditions of bu are able to describe an examination in form of a	testing and inspection of construction produce in the second	cts, the examina	-
Personal Competence				
Social Competence	The students can describe the different roles of framework of material testing. They can describe		-	on bodies within tl
Autonomy	The students are able to make the timing and the	operation steps to learn the specialist know	ledge of a very e	xtensive field.
Workload in Hours	Independent Study Time 124, Study Time in Lectu	ıre 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engine	ering: Elective Compulsory		
-	Civil Engineering: Specialisation Geotechnical Eng			
	Civil Engineering: Specialisation Coastal Engineer	ing: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic	: Elective Compulsory		
	International Management and Engineering: Spec	ialisation II. Civil Engineering: Elective Comp	oulsory	
	Materials Science and Engineering: Specialisation		-	
	Materials Science: Specialisation Engineering Mat			

Course L0260: Examination of	Course L0260: Examination of Materials, Structural Condition and Damages			
Тур	Lecture			
Hrs/wk	3			
СР	4			
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42			
Lecturer	Prof. Frank Schmidt-Döhl			
Language	DE			
Cycle	WiSe			
Content	Materials testing and marking process of construction products, testing methods for building materials and structures, testing			
	reports and expert opinions, describing the condition of a structure, from symptons to the cause of damages			
Literature	Frank Schmidt-Döhl: Materialprüfung im Bauwesen. Fraunhofer irb-Verlag, Stuttgart, 2013.			

Course L0261: Examination of Materials, Structural Condition and Damages		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Courses	T		Line (colo	<u></u>
Title Integrated Transportation Planning	Tyj (L1068) Pro	<b>p</b> ject-/problem-based Learning	Hrs/wk 4	<b>CP</b> 6
Module Responsible		,, p		-
Admission Requirements	None			
Recommended Previous		rgraduate class "Transport P	lanning and Tr	raffic Engineerin
Knowledge		. <u>.</u>	j	
Educational Objectives	After taking part successfully, students have reached the following le	earning results		
Professional Competence				
Knowledge	Students are able to:			
	• describe interdenendensies between land use/lesstion sheise	and transportation (mobility)	habaylayr	
	<ul> <li>describe interdependencies between land-use/location choice</li> <li>explain and evaluate the social, ecological and economic effect</li> </ul>			res
	<ul> <li>relate current issues in the area of integrated transport planni</li> </ul>			
Skills	Students are able to:			
	• supptify important parameters, which influence travel doman	d ar are influenced by it		
	<ul> <li>quantify important parameters, which influence travel demander</li> <li>comprehensively examine a pre-defined or self-selected topic</li> </ul>		es nersnective	and document t
	results in accordance with scientific conventions.		es perspective	
Personal Competence Social Competence	Students are able to:			
	<ul> <li>provide feedback on topical contents and their teaching.</li> <li>constructively handle feedback on their own work.</li> </ul>			
	<ul> <li>produce results in group work and document these.</li> </ul>			
	р			
Autonomy	Students are able to:			
	assess potential consequences of their future professional act	ivities		
	<ul> <li>independently plan working on a pre-defined project topic, ac</li> </ul>	quire the necessary knowled	ge and use ap	propriate means
	its execution.			
	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination	Written elaboration			
Examination duration and	written assignment with presentation during the semester			
scale Assignment for the	Civil Engineering: Specialization Structural Engineering: Elective Con	anulsony		
Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Con Civil Engineering: Specialisation Geotechnical Engineering: Elective C			
i chowing curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Composition Coastal Engineering: Elective Coastal Engineering: Electi			
	Civil Engineering: Specialisation Water and Traffic: Compulsory			
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and	nd Mobility: Elective Compuls	ory	
	Water and Environmental Engineering: Specialisation Cities: Compute	sory		

Course L1068: Integrated Tr	ansportation Planning
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß
Language	DE
Cycle	WiSe
	The course will provide students with an understanding of interdependencies between land-use and transportation. Specific topics include a.o.:    interactions between transport and the environment and consequent limitations  characteristics of integrated planning  complex planning processes  interdependencies of location choice and mobility behaviour  transport and land-use policies  project on current issues in transportation studies
Literature	Kutter, Eckhard (2019) Stadtstruktur und Erreichbarkeit in der postfossilen Zukunft. Erich Schmidt Verlag. Berlin. Gies, Huber u. a. (Hrsg.) (93. Ergänzung 2022) Handbuch der kommunalen Verkehrsplanung. Herbert Wichmann Verlag. Berlin, Offenbach. (Loseblattsammlung mit kontinuierlichen Ergänzungen)

Courses				
Title		Тур	Hrs/wk	СР
Chemistry of Drinking Water Treatment (L0311)		Lecture	2	1
Chemistry of Drinking Water Treatr	nent (L0312)	Recitation Section (large)	1	2
Water Resource Management (L04	02)	Lecture	2	2
Water Resource Management (L04)	03)	Recitation Section (small)	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
<b>Recommended Previous</b>	Knowledge of water management and the	e key processes involved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
<b>Professional Competence</b>				
Chille	water supply. They will understand relevant economic, environmental and social factors. Students will be able to explain outline the organisational structures of water companies. They will be able to explain the available water treatment processes the scope of their application.			
SKIIIS	5 Students will be able to assess complex problems in drinking water production and establish solutions involving was management and technical measures. They will be able to assess the evaluation methods that can be used for this. Students be able to carry out chemical calculations for selected treatment processes and apply generally accepted technical rules standards to these processes.			
Personal Competence				
Social Competence	Working in a diverse group of specialists, students will be able to develop and document complex solutions for the managem			
	and treatment of drinking water. They will be able to take an appropriate professional position, for example representing u			
	interests. They will be able to develop join	nt solutions in teams of diverse experts and prese	nt these solutions t	to others.
Autonomy	Students will be in a position to work on a subject independently and present on this subject.			
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (chemistry) + presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structura	al Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotech	nical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Water an	d Traffic: Compulsory		
	Civil Engineering: Specialisation Coastal E			
	International Management and Engineerin	ng: Specialisation II. Energy and Environmental En	gineering: Elective	Compulsory
		onmental Process Engineering: Elective Compulso		
	Process Engineering: Specialisation Proce	ss Engineering: Elective Compulsory		
	Water and Environmental Engineering: Sp	pecialisation Water: Compulsory		
	Water and Environmental Engineering: Sr	pecialisation Environment: Elective Compulsory		
	water and Environmental Engineering. Sp	celuisation Environment. Elective compusory		

Course L0311: Chemistry of	Drinking Water Treatment
	Lecture
Hrs/wk	
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Klaus Johannsen
Language	DE
Cycle	WiSe
Content	The topic of this course is water chemistry with respect to drinking water treatment and water distribution
	Major topics are solubility of gases, carbonic acid system and calcium carbonate, blending, softening, redox processes, materials and legal requirements on drinking water treatment. Focus is put on generally accepted rules of technology (DVGW- and DIN- standards). Special emphasis is put on calculations using realistic analysis data (e.g. calculation of pH or calcium carbonate dissolution potential) in exercises. Students can get a feedback and gain extra points for exam by solving problems for homework. Knowledge of drinking water treatment processes is vital for this lecture. Therefore the most important processes are explained coordinated with the course " Water resources management" in the beginning of the semester.
Literature	<ul> <li>MHW (rev. by Crittenden, J. et al.): Water treatment principles and design. John Wiley &amp; Sons, Hoboken, 2005.</li> <li>Stumm, W., Morgan, J.J.: Aquatic chemistry. John Wiley &amp; Sons, New York, 1996.</li> <li>DVGW (Hrsg.): Wasseraufbereitung - Grundlagen und Verfahren. Oldenbourg Industrie Verlag, München, 2004.</li> <li>Jensen, J. N.: A Problem Solving Approach to Aquatic Chemistry. John Wiley &amp; Sons, Inc., New York, 2003.</li> </ul>

Course L0312: Chemistry of Drinking Water Treatment		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Dr. Klaus Johannsen	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0402: Water Resour	ce Management
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Mathias Ernst
Language	DE
Cycle	WiSe
Content	The lecture provides comprehensive knowledge on interaction of water ressource management and drinking water supply. Content
	<ul> <li>overview:</li> <li>Current situation of global water resources</li> <li>User and Stakeholder conflicts</li> <li>Wasserressourcenmanagement in urbane Gebieten</li> <li>Rechtliche Aspekte, Organisationsformen Trinkwasserversorgungsunternehmen.</li> <li>Ökobilanzierung, Benchmarking in der Wasserversorgung</li> </ul>
Literature	<ul> <li>Aktuelle UN World Water Development Reports</li> <li>Branchenbild der deutschen Wasserwirtschaft, VKU (2011)</li> <li>Aktuelle Artikel wissenschaftlicher Zeitschriften</li> <li>Ppt der Vorlesung</li> </ul>

Course L0403: Water Resour	urse L0403: Water Resource Management		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Mathias Ernst		
Language	DE		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses		
Title Construction Robotics (L2867)	TypHrs/wkCPProject-/problem-based Learning66	I
Module Responsible	Prof. Kay Smarsly	
Admission Requirements	None	
<b>Recommended Previous</b>	Basics of project-oriented programming	
Knowledge		
-	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	Basics of robotics	
	Applications in civil engineering	
	Kinematics	
Skills	Use of specific hardware	
	Development of software routines	
	Python programming language	
	Image processing	
	Basics of localization (LIDAR, SLAM)	
Personal Competence		
Social Competence		
	Communication skills	
Autonomy	Independent work	
	Independent decisions	
Examination		
Examination duration and scale	ca. 10 Seiten	
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory	
-		
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory	
	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory	
	Civil Engineering: Specialisation Computational Engineering: Elective Compulsory	
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory	
	Mechatronics: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory	

τνρ	Project-/problem-based Learning	
Hrs/wk		
CP		
	Independent Study Time 96, Study Time in Lecture 84	
	Prof. Kay Smarsly, Jan Stührenberg	
Language		
Cycle		
Content	<ol> <li>Introduction: Robotics in civil engineering</li> <li>Presentation of potential topics</li> <li>Programming of algorithms in Python</li> <li>Application of software systems: LINUX distribution, ROS, CloudCompare,</li> <li>Application of hardware systems: Petoi Bittle Dog, Raspberry Pi, Arduino, sensing</li> <li>Topics considered for robotics using the Petoi Bittle Dog:         <ol> <li>Movement</li> <li>Use of sensors (camera, infrared,)</li> <li>Data structures/data acquisition</li> <li>Programming</li> </ol> </li> <li>Topics technically relevant to building inspection:         <ol> <li>Geodetic evaluations</li> <li>Image processing</li> <li>Localization</li> </ol> </li> </ol>	
Literature	Bock/Linner: Construction Robotics	
	Verl et al.: Soft Robotics	
	Pasquale: New Laws of robotics	

Courses				
Title		Тур	Hrs/wk	СР
Environmental Analysis (L0354)		Lecture	2	3
Environmental microbiology (L322	3)	Lecture	2	3
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundamentals of inorganic/organic chemistry and biology (knowledge acquired at school).			
Knowledge				
Educational Objectives	After taking part successfully, studer	ts have reached the following learning results		
<b>Professional Competence</b>				
Knowledge	On completion of this module, students will be able to describe the mechanisms of biological systems. They will know the m biological metabolic routes and can categorise their influence on global metabolic routes. They will be familiar with the ba analytical methods for investigating and assessing the quality of various environmental compartments.			
Skills	On completion of this module, students will be able to categorise which metabolism will predominate under which environment conditions. Students will be able to apply the theoretical principles they have learnt to exemplary sites and assess the resulting relationshi from a technical and conceptual perspective. They will be able to draw comparisons on different investigation strategies a techniques. Model projects can be devised and treated.			
Personal Competence				
Social Competence	The students are able to organize working processes within a team in a targeted way and based on the divison of labour.			
Autonomy	Students can independently exploit s	ources, acquire the particular knowledge of the s	ubject and apply it to ne	w problems.
Workload in Hours	Independent Study Time 124, Study	Time in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
	Civil Engineering: Specialisation Wat	ar and Traffic: Elective Compulsory		

Course L0354: Environmenta	l Analysis
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Dorothea Rechtenbach, Dr. Henning Mangels
Language	EN
Cycle	WiSe
Content	Introduction
	Sampling in different environmental compartments, sample transportation, sample storage
	Sample preparation
	Photometry
	Wastewater analysis
	Introduction into chromatography
	Gas chromatography
	HPLC
	Mass spectrometry
	Optical emission spectrometry
	Atom absorption spectrometry
	Quality assurance in environmental analysis
Literature	Roger Reeve, Introduction to Environmental Analysis, John Wiley & Sons Ltd., 2002 (TUB: USD-728)
	Pradyot Patnaik, Handbook of environmental analysis: chemical pollutants in air, water, soil, and solid wastes, CRC Press, Boca Raton, 2010 (TUB: USD-716)
	Chunlong Zhang, Fundamentals of Environmental Sampling and Analysis, John Wiley & Sons Ltd., Hoboken, New Jersey, 2007 (TUB: USD-741)
	Miroslav Radojević, Vladimir N. Bashkin, Practical Environmental Analysis RSC Publ., Cambridge, 2006 (TUB: USD-720)
	Werner Funk, Vera Dammann, Gerhild Donnevert, Sarah Iannelli (Translator), Eric Iannelli (Translator), Quality Assurance in Analytical Chemistry: Applications in Environmental, Food and Materials Analysis, Biotechnology, and Medical Engineering, 2nd Edition, WILEY-VCH Verlag GmbH & Co. KGaA,Weinheim, 2007 (TUB: CHF-350)
	STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER, 21st Edition, Andrew D. Eaton, Leonore S. Clesceri, Eugene W. Rice, and Arnold E. Greenberg, editors, 2005 (TUB:CHF-428)
	K. Robards, P. R. Haddad, P. E. Jackson, Principles and Practice of Modern Chromatographic Methods, Academic Press
	G. Schwedt, Chromatographische Trennmethoden, Thieme Verlag
	H. M. McNair, J. M. Miller, Basic Gas Chromatography, Wiley
	W. Gottwald, GC für Anwender, VCH
	B. A. Bidlingmeyer, Practical HPLC Methodology and Applications, Wiley
	K. K. Unger, Handbuch der HPLC, GIT Verlag
	G. Aced, H. J. Möckel, Liquidchromatographie, VCH
	Charles B. Boss and Kenneth J. Fredeen, Concepts, Instrumentation and Techniques in Inductively Coupled Plasma Optical Emissio
	Spectrometry Perkin-Elmer Corporation 1997, On-line available at: http://files.instrument.com.cn/bbs/upfile/2006291448.pdf
	Atomic absorption spectrometry: theory, design and applications, ed. by S. J. Haswell 1991 (TUB: 2727-5614)
	Royal Society of Chemistry, Atomic absorption spectometry (http://www.kau.edu.sa/Files/130002/Files/6785_AAs.pdf)

Course L3223: Environmenta	ıl microbiology	
Тур	Lecture	
Hrs/wk	Hrs/wk 2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Johannes Gescher	
Language	EN	
Cycle	WiSe	
Content	This lecture deals with the importance of microorganisms for biological material cycles and the health of water and soil. After the development of biochemical and cell biological basics, methods are presented that are necessary to investigate microbial communities and their activity. In addition, the role of microorganisms in the biogas process and in the biorefinery is discussed. The third part presents methods for purifying air, water and soil as well as environmentally friendly production processes involving microorganisms.	
Literature	Umweltmikrobiologie; Reineke, W. und Schlömann, M. (2015) 2. Aufl., Springer Spektrum Verlag Brock Mikrobiologie; Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl (2020) 15. Aufl., Pearson Studium Verlag	

Courses					
Title		Тур		Hrs/wk	СР
Biological Wastewater Treatment (I	.0517)	Lecture		2	2
Biological Wastewater Treatment (I	.3122)	Recitation Sect	ion (large)	1	1
Advanced Wastewater Treatment (	L0357)	Lecture		2	2
Advanced Wastewater Treatment (	L0358)	Recitation Sect	ion (large)	1	1
Module Responsible	Dr. Joachim Behrendt				
	None				
	Knowledge of wastewater management a	nd the key processes involved in wast	ewater treatmen	t.	
Knowledge					
Educational Objectives	After taking part successfully, students ha	ve reached the following learning res	ults		
Professional Competence					
Knowledge	Students are able to outline key areas of	the full range of treatment systems ir	n waste water ma	anagement, as	well as their mut
	dependence for sustainable water protect	ion. They can describe relevant econo	omic, environmer	ntal and social	factors.
Skills	Students are able to pre-design and exp	ain the available wastewater treatme	ent processes ar	ud the scone o	f their application
SKIIS	municipal and for some industrial treatme		ent processes un	ia the scope o	
	maneipar and for some madstrar creatine				
Personal Competence					
Social Competence	Social skills are not targeted in this module.				
4	Chudanta and in a paritien to work an a	autient and the annualize thesis would be	9 in den en den	+l	
Autonomy	Students are in a position to work on a	subject and to organize their work i	now independen	tiy. They can	also present on ti
	subject.				
Workload in Hours	Independent Study Time 96, Study Time i	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structura	I Engineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechr	ical Engineering: Elective Compulsory	/		
	Civil Engineering: Specialisation Coastal E	ngineering: Elective Compulsory			
	Civil Engineering: Specialisation Water an	d Traffic: Compulsory			
	Bioprocess Engineering: Specialisation A -	, , ,			
	Environmental Engineering: Specialisation			-	
	International Management and Engineerin	• •	-		
	International Management and Engineerin	5 1 5,	5	ering: Elective	Compulsory
	Process Engineering: Specialisation Enviro	• •	e Compulsory		
	Process Engineering: Specialisation Proces				
	Water and Environmental Engineering: Sp				
	Water and Environmental Engineering: Sp		mpulsory		
	Water and Environmental Engineering: Sp	ecialisation Cities: Compulsory			

Course L0517: Biological Wastewater Treatment		
Тур	Lecture	
Hrs/wk		
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Joachim Behrendt	
Language	DE/EN	
Cycle	SoSe	
Content	Charaterisation of Wastewater	
	Metobolism of Microorganisms	
	Kinetic of mirobiotic processes	
	Calculation of bioreactor for wastewater treatment	
	Concepts of Wastewater treatment	
	Design of WWTP	
	Excursion to a WWTP	
	Biofilms	
	Biofim Reactors	
	Anaerobic Wastewater and sldge treatment	
	resources oriented sanitation technology	
	Future challenges of wastewater treatment	
Literature	Gujer, Willi	
	Siedlungswasserwirtschaft : mit 84 Tabellen	

ISBN: 3540343296 (Gb.) URL: http://www.gbv.de/dms/bs/toc/516261924.pdf URL: http://deposit.d-nb.de/cgi-bin/dokserv?
id=2842122&prov=M&dok_var=1&dok_ext=htm
Berlin [u.a.] : Springer, 2007
TUB_HH_Katalog
Henze, Mogens
Wastewater treatment : biological and chemical processes
ISBN: 3540422285 (Pp.)
Berlin [u.a.] : Springer, 2002
TUB_HH_Katalog
Imhoff, Karl (Imhoff, Klaus R.;)
Taschenbuch der Stadtentwässerung : mit 10 Tafeln
ISBN: 3486263331 ((Gb.))
München [u.a.] : Oldenbourg, 1999
TUB_HH_Katalog
Lange, Jörg (Otterpohl, Ralf; Steger-Hartmann, Thomas;)
Abwasser : Handbuch zu einer zukunftsfähigen Wasserwirtschaft
ISBN: 3980350215 (kart.) URL: http://www.gbv.de/du/services/agi/52567E5D44DA0809C12570220050BF25/000000700334
Donaueschingen-Pfohren : Mall-Beton-Verl., 2000
TUB_HH_Katalog
Mudrack, Klaus (Kunst, Sabine;)
Biologie der Abwasserreinigung : 18 Tabellen
ISBN: 382741427X URL: http://www.gbv.de/du/services/agi/94B581161B6EC747C1256E3F005A8143/420000114903
Heidelberg [u.a.] : Spektrum, Akad. Verl., 2003
TUB_HH_Katalog
Tchobanoglous, George (Metcalf & Eddy, Inc., ;)
Wastewater engineering : treatment and reuse
ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk))
Boston [u.a.] : McGraw-Hill, 2003
TUB_HH_Katalog
Henze, Mogens
Activated sludge models ASM1, ASM2, ASM2d and ASM3
ISBN: 1900222248
London : IWA Publ., 2002
TUB_HH_Katalog
Kunz, Peter
Umwelt-Bioverfahrenstechnik
Vieweg, 1992
Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung für
Wasserwirtschaft, Abwasser und Abfall, ;)
Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe
aus der Abwasserbehandlung, Kleinkläranlagen
ISBN:         3860682725 URL:         http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf         URL:
http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf
Weimar : Universitätsverl, 2006
TUB_HH_Katalog
Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall
DWA-Regelwerk
Hennef : DWA, 2004
TUB_HH_Katalog
Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;)
Fundamentals of biological wastewater treatment
ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm
Weinheim : WILEY-VCH, 2007
TUB_HH_Katalog

Course L3122: Biological Wa	Course L3122: Biological Wastewater Treatment	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Joachim Behrendt	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0357: Advanced Wa	stewater Treatment
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Joachim Behrendt
Language	EN
Cycle	SoSe
Content	Survey on advanced wastewater treatment
	reuse of reclaimed municipal wastewater
	Precipitation
	Flocculation
	Depth filtration
	Membrane Processes
	Activated carbon adsorption
	Ozonation
	"Advanced Oxidation Processes"
	Disinfection
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung,
	Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003

Course L0358: Advanced Was	stewater Treatment
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Joachim Behrendt
Language	EN
Cycle	SoSe
Content	Aggregate organic compounds (sum parameters)
	Industrial wastewater
	Processes for industrial wastewater treatment
	Precipitation
	Flocculation
	Activated carbon adsorption
	Recalcitrant organic compounds
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003

_				
Courses				
Title		Тур	Hrs/wk	СР
Noise Protection (L1109) Urban Infrastructures (L0874)		Lecture Project-/problem-based Learning	2 2	2
	Dr. Dorothea Rechtenbach	Hoject-/problem-based Learning	2	7
Admission Requirements				
Recommended Previous	None			
Kecommended Previous Knowledge	Knowledge on Urban planning			
Kilowiedge	Knowledge on measures for climate protection			
	General knowledge of scientific writing/working			
Educational Objectives	After taking part successfully, students have reached the follo	wing learning results		
Professional Competence				
•	Students can describe urban development corridors as well a	s current and future urban environ	mental probler	ms. They are able
	explain the causes of environmental problems (like noise).			
	Students can specify applications for various technical innova	tions and explain why these contri	bute to the im	provement of url
	life. They can, for example, derive and discuss measures for effective noise abatement.			
Skille			problems of ur	
JKIIIS	Students are able to develop specific solutions for correcting existing or future environment-related problems of urba development. They can define a range of conceptual and technical solutions for environmental problems for different development.			
	paths. To solve specific urban environmental problems they			
	context.		na megrate t	inem into the un
Personal Competence				
•	The students can work together in international groups.			
Autonomy	Students are able to organize their work flow to prepare then		ributions to th	ne discussions. Tl
	can acquire appropriate knowledge by making enquiries indep	pendently.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Written Report plus oral Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Election	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Ele	ective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective			
	Civil Engineering: Specialisation Water and Traffic: Elective Co			
	Environmental Engineering: Core Qualification: Elective Comp	•		
	Joint European Master in Environmental Studies - Cities and Su	•		
	Logistics, Infrastructure and Mobility: Specialisation Infrastruct		ory	
	Water and Environmental Engineering, Creciplication Environment	erent. Elective Communication		
	Water and Environmental Engineering: Specialisation Environ Water and Environmental Engineering: Specialisation Cities: C			

Course L1109: Noise Protect	Course L1109: Noise Protection		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Martin Jäschke		
Language	EN		
Cycle	SoSe		
Content			
Literature	1) Müller & Möser (2013): Handbook of Engineering Acoustics (also available in German)		
	2) WHO (1999): Guidelines for Community Noise		
	3) Environmental Noise Directive 2002/49/EG		
	4) ISO 9613-2 (1996): Acoustics, Attenuation of sound during propagation outdoors, Part 2: General method of calculation		

Course L0874: Urban Infrast	urse L0874: Urban Infrastructures		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Lecturer	Dr. Dorothea Rechtenbach		
Language	EN		
Cycle	SoSe		
Content	Problem Based Learning Main topics are: • Central vs. Decentral Wastewater Treatment. • Compaction of Cities. • Car Free Cities. • Multifunctional Places in Cities. • The Sustainability of Freight Transport in Cities.		
Literature	Depends on chosen topic.		

Courses				
Title		Тур	Hrs/wk	СР
	ergy, Soil and Food Nexus (L1229)	Seminar	2	2
Water & Wastewater Systems in a	Global Context (L0939)	Lecture	2	4
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge of the global situation with	h rising poverty, soil degradation, mig	ration to cities, lack of	water resources a
Knowledge	sanitation			
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
	Students can describe the facets of the globa	al water situation. Students can iudge the	e enormous potential of the	ne implementation
	synergistic systems in Water, Soil, Food and			
Skills	Students are able to design ecological settle	ements for different geographic and soc	io-economic conditions f	or the main clima
	around the world.			
Personal Competence				
	The students are able to develop a specific topic in a team and to work out milestones according to a given plan.			
···· //···			5 - 5 - 1	
Autonomy	Students are in a position to work on a subject and to organize their work flow independently. They can also present on			also present on th
	subject.			
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	During the course of the semester, the students work towards mile stones. The work includes presentations and papers. Detail			
scale	information can be found at the beginning of	the smester in the StudIP course module	e handbook.	
Assignment for the	Civil Engineering: Specialisation Water and T	raffic: Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - Ge	eneral Bioprocess Engineering: Elective C	Compulsory	
	Chemical and Bioprocess Engineering: Specia	alisation General Process Engineering: El	ective Compulsory	
	Environmental Engineering: Core Qualification	n: Elective Compulsory		
	Joint European Master in Environmental Stud	ies - Cities and Sustainability: Core Quali	fication: Compulsory	
	Process Engineering: Specialisation Environm	nental Process Engineering: Elective Com	ipulsory	
	Process Engineering: Specialisation Process I	Engineering: Elective Compulsory		
	Water and Environmental Engineering: Speci	alisation Water: Elective Compulsory		
	Water and Environmental Engineering: Speci	alisation Environment: Elective Compulse	ory	
	Water and Environmental Engineering: Speci	alisation Cities: Elective Compulsory		

Course L1229: Ecological Tov	wn Design - Water, Energy, Soil and Food Nexus
Тур	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	SoSe
Content	<ul> <li>Participants Workshop: Design of the most attractive productive Town</li> <li>Keynote lecture and video</li> <li>The limits of Urbanization / Green Cities</li> <li>The tragedy of the Rural: Soil degradation, agro chemical toxification, migration to cities</li> <li>Global Ecovillage Network: Upsides and Downsides around the World</li> <li>Visit of an Ecovillage</li> <li>Participants Workshop: Resources for thriving rural areas, Short presentations by participants, video competion</li> <li>TUHH Rural Development Toolbox</li> <li>Integrated New Town Development</li> <li>Participants workshop: Design of New Towns: Northern, Arid and Tropical cases</li> <li>Outreach: Participants campaign</li> <li>City with the Rural: Resilience, quality of live and productive biodiversity</li> </ul>
Literature	<ul> <li>Ralf Otterpohl 2013: Gründer-Gruppen als Lebensentwurf: "Synergistische Wertschöpfung in erweiterten Kleinstadt- und Dorfstrukturen", in "Regionales Zukunftsmanagement Band 7: Existenzgründung unter regionalökonomischer Perspektive, Pabst Publisher, Lengerich</li> <li>http://youtu.be/9hmkgn0nBgk (Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation)</li> <li>TEDx New Town Ralf Otterpohl: http://youtu.be/_M0J2u9BrbU</li> </ul>

Course L0939: Water & Wast	Course L0939: Water & Wastewater Systems in a Global Context		
Тур	Lecture		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Lecturer	Prof. Ralf Otterpohl		
Language	EN		
Cycle	SoSe		
Content			
	<ul> <li>Keynote lecture and video</li> <li>Water &amp; Soil: Water availability as a consequence of healthy soils</li> <li>Water and it's utilization, Integrated Urban Water Management</li> <li>Water &amp; Energy, lecture and panel discussion pro and con for a specific big dam project</li> <li>Rainwater Harvesting on Catchment level, Holistic Planned Grazing, Multi-Use-Reforestation</li> <li>Sanitation and Reuse of water, nutrients and soil conditioners, Conventional and Innovative Approaches</li> <li>Why are there excreta in water? Public Health, Awareness Campaigns</li> <li>Rehearsal session, Q&amp;A</li> </ul>		
Literature	<ul> <li>Montgomery, David R. 2007: Dirt: The Erosion of Civilizations, University of California Press</li> <li>Liu, John D.: http://eempc.org/hope-in-a-changing_climate/ (Integrated regeneration of the Loess Plateau, China, and sites in Ethiopia and Rwanda)</li> <li>http://youtu.be/9hmkgn0nBgk (Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation)</li> </ul>		

Courses	
Fitle	Typ Hrs/wk CP
City Planning (L1066)	Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
<b>Recommended Previous</b>	for "Principles of Urban Planning": none
Knowledge	for "Designing Urban Streetscapes": some knowledge of transport planning, e.g. through taking the undergraduate class "Tra
	Planning and Traffic Engineering"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to:
	use technical terms of urban planning.
	describe the main determinants of urban development.
	<ul> <li>explain and compare different possibilities of how urban development can be influenced.</li> </ul>
	discuss requirements for public streetscapes.
	explain the importance of street design.
Skills	Students are able to:
	<ul> <li>read and analyze urban development concepts and designs for streetscapes</li> </ul>
	<ul> <li>appraise such concepts in the context of competing requirements.</li> </ul>
	design, justify and reflect their own solutions for concrete examples.
Personal Competence	
Social Competence	Students are able to:
	discuss intermediate results with each other.
	constructively accept feedback on their own work.
	provide constructive feedback to others.
Autonomy	Students are able to:
	<ul> <li>independently complete a written report including drawings following a broadly pre-defined process.</li> </ul>
	assess the consequences of their proposed solutions.
	<ul> <li>independently acquire knowledge and apply this to new issues or problem areas.</li> </ul>
	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement Examination	
Examination duration and	
scale	
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory

Course L1066: City Planning	
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	SoSe
Content	"Principles of Urban Planning" deals with the determinants of urban development and their interactions. Topics include:
	<ul> <li>legal framework,</li> <li>instruments and methods of planning,</li> <li>functional requirements,</li> <li>stakeholders and actors</li> <li>basic design requirements</li> <li>different planning levels and</li> <li>historical contexts.</li> </ul> The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functional and aesthetic requirements for designing streetscape as the most important elements of public space. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept, a building masterplan and a street redesign.
Literature	Albers, Gerd; Wekel, Julian (2021) Stadtplanung: Eine illustrierte Einführung. 4. überarbeitete Auflage. Primus Verlag. Darmstadt. Frick, Dieter (2011) Theorie des Städtebaus: Zur baulich-räumlichen Organisation von Stadt. 3. veränderte Auflage. Wasmuth- Verlag. Tübingen Jonas, Carsten (2009) Die Stadt und ihr Grundriss. Wasmuth-Verlag. Tübingen Kostof, Spiro; Castillo, Greg (1998) Die Anatomie der Stadt. Geschichte städtischer Strukturen. Campus-Verlag. Frankfurt/New York.

-				
Courses				
Title	Тур		Hrs/wk	СР
Construction Logistics (L1163)	Lectu	re	1	2
Construction Logistics (L1164)		ation Section (small)	1	2
Project Development and Managen			1	1
Project Development and Managen		ct-/problem-based Learning	1	1
Module Responsible	Prof. Heike Flämig			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following lea	rning results		
Professional Competence				
Knowledge	Students can			
	<ul> <li>give definitions of the main terms of construction logistics and p</li> </ul>		anagement	
	<ul> <li>name advantages and disadvantages of internal or external con</li> </ul>			
	<ul> <li>explain characteristics of products, demand and production of of</li> </ul>	construction objects and th	eir consequer	nces for constructio
	specific supply chains			
	<ul> <li>differentiate constructions logistics from other logistics systems</li> </ul>			
Skills	Students can			
	<ul> <li>carry out project life cycle assessments</li> </ul>			
	<ul> <li>apply methods and instruments of construction logistics</li> </ul>			
	<ul> <li>apply methods and instruments of project development and ma</li> </ul>	nagement		
	<ul> <li>apply methods and instruments of conflict management</li> </ul>			
	<ul> <li>design supply and waste removal concepts for a construction pr</li> </ul>	oject		
Personal Competence				
Social Competence	Students con			
Social Competence				
	<ul> <li>hold presentations in and for groups</li> </ul>			
	<ul> <li>apply methods of conflict solving skills in group work and case s</li> </ul>	tudies		
Autonomy	Students can			
	<ul> <li>solve problems by holistic, systemic and flow oriented thinking</li> </ul>			
	improve their creativity, negotiation skills, conflict and crises	solution skills by applying	methods of	moderation in cas
	studies			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Two written papers with presentations			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Comp	ulsory		
Following Curricula				
<b>5</b>	Civil Engineering: Specialisation Coastal Engineering: Elective Compute			
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsor	•		
	International Management and Engineering: Specialisation II. Civil Engi		ory	
	International Management and Engineering: Specialisation II. Logistics		-	
	incernational Management and Engineering. Specialisation II. Logistics			
	Logistics, Infrastructure and Mobility: Specialisation Production and Log		/	

ourse L1163: Construction	Logistics
Тур	Lecture
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig
Language	DE
Cycle	SoSe
Content	The lecture gives deeper insight how important logistics are as a competetive factor for construction projects and which issues are to be adressed. The following toppics are covered: • competetive factor logistics • the concept of systems, planning and coordination of logistics • the concept of systems, planning and coordination of logistics • material, equipment and reverse logistics • IT in construction logistics • elements of the planning model of construction logistics and their connections • flow oriented logistics systems for construction projects • logistics concepts for ready to use construction projects (especially procurement and waste removel logistics) • best practice examples (construction logistics Potsdamer Platz, recent case study of the region) Contents of the lecture are deepened in special exercises.
Literature	Flämig, Heike: Produktionslogistik in Stadtregionen. In: Forschungsverbund Ökologische Mobilität (Hrsg.) Forschungsbericht Bd 15.2. Wuppertal 2000. Krauss, Siri: Die Baulogistik in der schlüsselfertigen Ausführung, Bauwerk Verlag GmbH Berlin 2005. Lipsmeier, Klaus: Abfallkennzahlen für Neubauleistungen im Hochbau : Verlag Forum für Abfallwirtschaft und Altlasten, 2004. Schmidt, Norbert: Wettbewerbsfaktor Baulogistik. Neue Wertschöpfungspotenziale in der Baustoffversorgung. In: Klaus, Peter Edition Logistik. Band 6. Deutscher Verkehrs-Verlag. Hamburg 2003. Seemann, Y.F. (2007): Logistikkoordination als Organisationseinheit bei der Bauausführung Wissenschaftsverlag Mainz in Aachen, Aachen. (Mitteilungen aus dem Fachgebiet Baubetrieb und Bauwirtschaft (Hrsg. Kuhne, V.): Heft 20)

Course L1164: Construction	ourse L1164: Construction Logistics	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Heike Flämig	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

ourse L1161: Project Development and Management	
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei
Language	DE
Cycle	SoSe
Content	Within the lecture, the main aspects of project development and management are tought:
	<ul> <li>Terms and definitions of project management</li> <li>Advantages and disadvantages of different ways of project handling</li> <li>organization, information, coordination and documentation</li> <li>cost and fincance management in projects</li> <li>time- and capacity management in projects</li> <li>specific methods and instruments for successful team work</li> </ul> Contents of the lecture are deepened in special exercises.
Literature	Projektmanagement-Fachmann. Band 1 und Band 2. RKW-Verlag, Eschborn, 2004.

ourse L1162: Project Development and Management	
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Heike Flämig, Dr. Anton Worobei
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

## Module M0593: Building Materials and Building Preservation

Courses						
Title			Тур		Hrs/wk	СР
Repair of Structures (L0255)			Lecture		1	1
Mineral Building Materials (L0253)			Lecture		2	2
Technology of mineral Building Mat	erials (L0256)		Project-/p	problem-based Learning	1	2
Transport Processes in Building Mat	erials and Damage Proce	sses (L0254)	Lecture		1	1
Module Responsible	Prof. Frank Schmidt-Dö	ihl				
Admission Requirements	None					
<b>Recommended Previous</b>	Basic knowledge about	it building materials, b	uilding physics and buildin	g chemistry, for exam	ple by the m	nodules Principles
Knowledge	Building Materials and	Building Physics and Bu	ilding Materials and Building	g Chemistry.		
Educational Objectives	After taking part succe	ssfully, students have r	eached the following learnin	ig results		
<b>Professional Competence</b>						
Knowledge	The students are able to describe the components of mineral building materials and their function in detail and to use them for the manufacture of special mineral building materials. They are able to show the characteristics of mineral building materials. They a able to describe the manufacture, properties and fields of application of special mortars and special concretes and the correlation of their material parameters. They are able to show the principles of anchor technology and design.					
Skills	The students are able to perform an optimization of granulometry of a mineral building material. They are able to design a spec mineral mortar and to manufacture this mortar. The students are able to manufacture post installed rebar connections. They a able to recognize damages, to assess possible causes, to use the fundamentals of construction preservation and to select repr and strengthening measures.					
Personal Competence						
Social Competence	The students are able to develop in small grous the mixture of a special mortar. They present their results to the lecturer and the other students. In a critical discussion they defend and adjust their results. The students are able to manufacture their spect building material on the basis of this feedback.					
Autonomy	The students are able to responsibly use the resources of materials and lab equipment for their project and to investigate and to get missing components.					
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70					
Credit points	6					
Course achievement	CompulsoryBonusYes20 %	Form Subject theoretical practical work	Description and			
Examination	Written exam					
Examination duration and scale	120 min					
	Civil Engineering: Spec	ialisation Geotechnical	Engineering: Compulsory			
Following Curricula			eering: Elective Compulsory	,		
i onowing curricula						
	Civil Engineering, Spec	vialisation Structural Env	gineering: Elective Compulso	אראר		

Course L0255: Repair of Structures	
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	SoSe
Content	Maintenance of structures, repair and strengthening, subsequent waterproofing of structures
Literature	BetonMarketing Deutschland (Hrsg.): Stahlbetonoberflächen - schützen, erhalten, instandsetzen

Course L0253: Mineral Buildi	Course L0253: Mineral Building Materials	
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Components of mineral building materials and their function, binding materials, concrete and mortar, special mortars, special	
	concretes	
Literature	Taylor, H.F.W.: Cement Chemistry	
	Springenschmid, R.: Betontechnologie für die Praxis	

Course L0256: Technology of	Course L0256: Technology of mineral Building Materials	
Тур	Project-/problem-based Learning	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Design and production of a special mineral building material	
Literature	Taylor, H.F.W.: Cement Chemistry	
	Springenschmid, R.: Betontechnologie für die Praxis	

Course L0254: Transport Processes in Building Materials and Damage Processes		
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Frank Schmidt-Döhl	
Language	DE	
Cycle	SoSe	
Content	Transport Processes in Building Materials and Damage Processes	
Literature	Blaich, J.: Bauschäden, Analyse und Vermeidung	

Courses					
Title		Тур	Hrs/wk	СР	
Structural Dynamics (L1202)		Lecture	2	2	
Structural Dynamics (L1203)		Recitation Section (large)	2	2	
Fracture mechanics and fatigue in	steel structures (L0564)	Lecture	1	1	
Fracture mechanics and fatigue in	steel structures (L0565)	Recitation Section (large)	1	1	
Module Responsible	Prof. Bastian Oesterle				
Admission Requirements	None				
<b>Recommended Previous</b>	Knowledge of linear structural analysis	of statically determinate and indeterminate struct	tures; Mechanics	I/II, Mathematics	
Knowledge	Differential equations I				
Educational Objectives	After taking part successfully, students h	nave reached the following learning results			
Professional Competence	Arter taking part successiony, students i	lave reached the following learning results			
•	After successful completion of this may	tule the student can explain the basic aspects of	dunamia offacta a	an atructures and	
Kilowiedge	respective methods.	lule, the student can explain the basic aspects of o		on scructures and	
Skills		odule, the students will be able to predict the re	sponse of mater	ial and structures	
	dynamics loading using the appropriate computational approaches and methods.				
Personal Competence					
Social Competence	Students can				
	<ul> <li>participate in subject specific and</li> </ul>	interdisciplingry discussions			
	participate in subject-specific and interdisciplinary discussions,				
	<ul> <li>defend their own work results in front of others</li> <li>promote the scientific development of colleagues</li> </ul>				
		•			
	<ul> <li>Furthermore, they can give and a</li> </ul>	ccept professional constructive criticism			
Autonomy	Students are able to gain knowledge of	the subject area from given and other sources and a	apply it to new pr	oblems. Furthermo	
	they are able to structure the solution process for problems in the area of Structural Analysis.				
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84			
Credit points	6				
Course achievement					
Examination					
Examination duration and	150 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structur	ral Engineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotech	nnical Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal	Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Water a	nd Traffic: Elective Compulsory			
	Civil Engineering: Specialisation Comput	ational Engineering: Elective Compulsory			

Course L1202: Structural Dy	namics	
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Bastian Oesterle	
Language	DE	
Cycle	SoSe	
Content	<ul> <li>mechanical background of dynamics</li> <li>harmonic vibrations, damped and undamped free and forced vibrations</li> <li>frequency and time domain</li> <li>modelling aspects</li> <li>principle of d'Alembert</li> <li>systems with multiple degrees of freedom</li> <li>consistent and lumped mass matrices</li> <li>finite elements for dynamics problems</li> <li>impact problems</li> <li>eigenvalue problems and modal analysis</li> <li>direct time integration schemes, transient analyses</li> </ul>	
Literature	<ul> <li>Vorlesungsmanuskript</li> <li>Clough, R.W., Penzien, J.: Dynamics of Structures. 2. Aufl., McGraw-Hill, New York, 1993.</li> </ul>	

Course L1203: Structural Dy	ourse L1203: Structural Dynamics		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Bastian Oesterle		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Workload in Hours Lecturer	Independent Study Time 16, Study Time in Lecture 14
Lecturer	
	Dr. Jürgen Priebe
Language	
	DE
Cycle	SoSe
Content	<ul> <li>basics of fatigue stress and fatigue resistance and determination of fatigue strength,</li> </ul>
	determination and use of S-N-curves and classification of notch effects,
	• set up of determination of fatigue strength under dynamic load using the accumulation formula by Palmgren-Miner,
	set up of determination of fatigue strength in different examples,
	<ul> <li>basics of construction and design regarding the problem of material fatigue,</li> </ul>
	basics of linear elastic fracture mechanics under static and dynamic load,
	determination of lifetime of steel construction based on linear elastic fracture mechanics in different examples.
Literature	Seeßelberg, C.; Kranbahnen - Bemessung und konstruktive Gestaltung; 3. Auflage; Bauwerk-Verlag; Berlin 2009
	Kuhlmann, Dürr, Günther; Kranbahnen und Betriebsfestigkeit; in Stahlbau Kalender 2003; Verlag Ernst & Sohn; Berlin 2003
	Deutscher Stahlbau-Verband (Hrsg.); Stahlbau Handbuch Band 1 Teil B; 3. Auflage; Stahlbau-Verlagsgesellschaft; Köln 199
	Petersen, C.; Stahlbau; 3. überarb. und erw. Auflage; Vieweg-Verlag; Braunschweig 1993
	<ul> <li>DIN V ENV 1993-1-1: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 1-1: Allgemeine Bemessungsreg</li> <li>Bemessungsregeln f         ür den Hochbau; 1993</li> </ul>
	• DIN V ENV 1993-6: Eurocode 3; Bemessung und Konstruktion von Stahlbauwerken; Teil 6: Kranbahnen; 2001
	• DIN-Fachbericht 126. Richtlinie zur Anwendung von DIN V ENV 1993-6; Nationales Anwendungsdokument (NAD); Berlin 20

Course L0565: Fracture mechanics and fatigue in steel structures		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Jürgen Priebe	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0982: Trans	portation Modelling		
Courses			
Title	Тур	Hrs/wk	СР
Transportation Modelling (L1180)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Carsten Gertz		
Admission Requirements	None		
<b>Recommended Previous</b>	some knowledge of transport planning, e.g. through taking the undergraduate class "Transport P	lanning and T	Traffic Engineering
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	Students are able to understand the operation and potential applications of transport models.		
Skille	Students are able to:		
JKIII5			
	<ul> <li>use travel demand modelling software packages for solving practical problems.</li> </ul>		
	<ul> <li>design a database structure for travel demand models.</li> </ul>		
	assess modelling results.		
	<ul> <li>appraise potential applications and limitations of such models.</li> </ul>		
	<ul> <li>Students are able to independently develop and document solutions.</li> <li>Students are able to: <ul> <li>independently organise, manage and solve set tasks.</li> <li>independently prepare written reports.</li> </ul> </li> </ul>		
Werklood in Hours	Jadenandent Study Time 124, Study Time in Lecture 56		
	Independent Study Time 124, Study Time in Lecture 56		
Credit points Course achievement			
	Written elaboration		
examination duration and scale	written assignment with presentation during the semester		
	Civil Engineering: Specialisation Water and Traffic: Compulsory		
-	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compuls	00/	
Following Curricula	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory	ory	

Course L1180: Transportation Modelling			
Тур	Project-/problem-based Learning		
Hrs/wk			
СР	5		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Lecturer	Prof. Carsten Gertz		
Language	DE		
Cycle	SoSe		
Content	<ul> <li>Principles of transport modelling</li> <li>Role of transport modelling in the planning process</li> <li>Fundamentals of mobility behaviour</li> <li>Design and evaluation of transport/mobility surveys</li> <li>mode of operation and data requirements for different stages of modelling</li> <li>Forecasting and scenarios in the transport planning</li> <li>The range of model applications (from transport infrastructure planning over simulation of traffic flows to integrated land-use and transport models as well as the use of models for evaluating locations)</li> <li>Practice-oriented project for assessing consequences of infrastructure projects and changes in land-use</li> </ul>		
Literature	Lohse, Dieter und Schnabel, Werner (2011): Grundlagen der Straßenverkehrstechnik und der Verkehrsplanung – Band 2. 3. Auflage. Beuth. Ortúzar, Juan de Dios und Willumsen, Luis G. (2011): Modelling Transport. 4. Auflage. John Wiley & Sons.		

Module M0827: Mode	ling in Water Management					
Courses						
Title		Тур	Hrs/wk	СР		
Groundwater Modeling using Modfl	ow (L0543)	Lecture	1	1		
Groundwater Modeling using Modfl		Recitation Section (small)	2	2		
Modeling of Water Supply Network		Project-/problem-based Learning	2	3		
Module Responsible						
Admission Requirements						
Recommended Previous	Groundwater					
Knowledge	• groundwater hydraulics and transport of su	ubstances				
	Pipe Systems					
	Knowledge on urban water infrastructure	es, in particular drinking water systemsand ι	ırban drainag	je systems includin		
	special structures					
	Hydraulics of drinking water supply system	is and sewer systems				
	Basic knowledge on water management	Basic knowledge on water management				
Educational Objectives	After taking part successfully, students have read	hed the following learning results				
Professional Competence						
Knowledge	The students are able to describe the modelling of	f groundwater flow and transport as well as urb	an water infr	astructures. They ca		
	carry out systems analyses and can detect technical and conceptual weak points within the systems in case studies. Besides the					
	are able to analyse interdependencies of hydraulic and toxic phenomena in soil and water.					
Skills	The students are able to construct and apply scientific groundwater models indipendently. They can work on different scenarios					
	and can compare or assess different solutions for existing problems by application of selected software products. The students are					
	able to use different software solutions (e.g. EPANET, EPA-SWMM).					
Personal Competence						
Social Competence	Wird nicht vermittelt.					
Autonomy	Wird nicht vermittelt.					
Workload in Hours	Independent Study Time 110, Study Time in Lecto	ure 70				
Credit points						
Course achievement	None					
Examination	Oral exam					
Examination duration and	30 min					
scale						
Assignment for the	Civil Engineering: Specialisation Structural Engine	eering: Elective Compulsory				
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng	jineering: Elective Compulsory				
	Civil Engineering: Specialisation Coastal Engineer	ing: Elective Compulsory				
	Civil Engineering: Specialisation Water and Traffic	: Elective Compulsory				
	Civil Engineering: Specialisation Computational E					
	Water and Environmental Engineering: Specialisa					
	Water and Environmental Engineering: Specialisa					
	Water and Environmental Engineering: Specialisa	tion water: Elective Compulsory				

Course L0543: Groundwater	Modeling using Modflow
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Sonja Götz
Language	DE/EN
Cycle	SoSe
Content	Introduction and application of the groundwater model MODFLOW (PMWIN); theoretical backround of the modell, students do work
	with the model PMWIN for practical case studies.
Literature	MODFLOW-Handbuch
	Chiang, Wen Hsien: PMWIN

Course L0544: Groundwater	rse L0544: Groundwater Modeling using Modflow		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Sonja Götz		
Language	DE/EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0875: Modeling of W	ourse L0875: Modeling of Water Supply Network		
Тур	Project-/problem-based Learning		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Klaus Johannsen		
Language	DE		
Cycle	SoSe		
Content			
Literature	Mutschmann/Stimmelmayr: Taschenbuch der Wasserversorgung, 16. Auflage. Springer Vieweg - Verlag. Wiesbaden 2014.		

Courses				
Title		Тур	Hrs/wk	СР
Modelling of Flow in Rivers and Est		Lecture	3	4
	ring / Integrated Flood Protection (L0961)	Project-/problem-based Learnir	g 2	2
Module Responsible				
Admission Requirements				
	Fundamentals of Hydromechanics, Hydraulics,	Hydrology and Hydraulic Engineering; Hyd	draulic Engineer	ring I and Hydrau
Knowledge	Engineering II			
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic processes that are related to the modelling of flows in hydraulic enginee Besides, they can describe the basic aspects of numerical modelling and actual numerical models for the simulation of flows			
		-	odels for the sir	nulation of nows a
	waves. They can also depict the concepts of nature oriented hydraulic engineering.			
Skills Students are able to apply hydrodynamic-numerical models to practical hydraulic engineering tasks.				ore, the students
	able to set up flood-risk management concepts and are able to apply basic concepts of renaturation to practical prob			
Personal Competence				
	The students are able to deploy their gained kn	owledge in applied problems of the practical	natura bacad b	vdraulic opginoori
Social Competence	Additionaly, they will be able to work in team wit		nature-based n	yuraulic engineeri
Autonomy	The students will be able to independently exten	•		
Autonomy	The students will be able to independently exten	in their knowledge and apply it to new problem	115.	
Workload in Hours	Independent Study Time 110, Study Time in Lect	ture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 150 min. T	he examination includes tasks with respect	to the general	understanding of
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Water and Traff	c: Compulsory		
Following Curricula	Environmental Engineering: Core Qualification: E	lective Compulsory		
	Joint European Master in Environmental Studies	- Cities and Sustainability: Core Qualification:	Compulsory	
	Water and Environmental Engineering: Specialisa	ation Water: Compulsory		
	Water and Environmental Engineering: Specialisa	ation Environment: Compulsory		
	Water and Environmental Engineering: Specialisa			

Course L0810: Modelling of	Flow in Rivers and Estuaries
Тур	Lecture
Hrs/wk	
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Edgar Nehlsen, Prof. Peter Fröhle
Language	EN
Cycle	SoSe
Content	Introduction to numerical flow modelling
	<ul> <li>Processes affecting tht flow</li> <li>Examples and applications of numerical models</li> <li>Procedure of numerical modelling</li> <li>Model concept</li> </ul> Basic equations of hydrodynamics
	Saint-Venant equations
	Euler Equations
	Navier-Stokes equations     Revealds averaged Navier Stokes equations
	Reynolds-averaged Navier-Stokes equations     Shallow water equations
	Solving schemes
	Numerical discretization
	Solution algorithms
	Convergence
Literature	Vorlesungsskript
	Literaturempfehlungen
	Bund der Ingenieure für Wasserwirtschaft, Abfallwirtschaft und Kulturbau (1997): Hydraulische Berechnung von naturnahen Fließgewässern. Düsseldorf: BWK (BWK-Merkblatt).
	Chow, Ven-te (1959): Open-channel Hydraulics. New York usw.: McGraw-Hill (McGraw-Hill Civil Engineering Series).
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019a): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 1: Geodaten in der Fließgewässermodellierung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-1).
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019b): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 2: Bedarfsgerechte Datenerfassung und -aufbereitung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-2).
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019c): Merkblatt DWA-M 543-3 Geodaten in der Fließgewässermodellierung - Teil 3: Aspekte der Strömungsmodellierung und Fallbeispiele. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-3).
	Hervouet, Jean-Michel (2007): Hydrodynamics of free surface flows. Modelling with the finite element method. Chichester: Wiley. Online verfügbar unter http://www.loc.gov/catdir/enhancements/fy0741/2007296953-b.html.
	IAHR (2015): Professional Specifications for Physical and Numerical Studies in Environmental Hydraulics. In: Hydrolink (3/2015), S. 90-92.
	Olsen, Nils Reidar B. (2012): Numerical Modelling and Hydraulics. 3. Aufl. Department of Hydraulic and Environmental Engineering, The Norwegian University of Science and Technology.
	Szymkiewicz, Romuald (2010): Numerical modeling in open channel hydraulics. Dordrecht: Springer (Water science and technology library, 83).
	van Waveren, Harold (1999-): Good modelling practice handbook. [Utrecht], Lelystad, Den Haag: STOWA; Rijkswaterstaat-RIZA; SDU, afd. SEO/RIZA [etc. distr.] (Nota, nr. 99.036).
	Zielke, Werner (Hg.) (1999): Numerische Modelle von Flüssen, Seen und Küstengewässern. Deutscher Verband für Wasserwirtschaft und Kulturbau. Bonn: Wirtschafts- und VerlGes. Gas und Wasser (Schriftenreihe des Deutschen Verbandes für Wasserwirtschaft und Kulturbau, 127).

Course L0961: Nature-Orient	ted Hydraulic Engineering / Integrated Flood Protection
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Natasa Manojlovic, Prof. Peter Fröhle
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>Regime-Theory and application for the development of environmental guiding priciples of rivers</li> <li>Engineering - biological measures for the stabilization of rivers</li> <li>Risk management in flood protection</li> <li>Design techniques in technical flood protection</li> <li>Methods for the assessment of flood caused damages</li> </ul>
Literature	Vorlesungsumdruck

Courses					
Title		Тур	Hrs/wk	СР	
Harbour Engineering (L0809)		Lecture	2	2	
Harbour Engineering (L1414)		Project-/problem-based Learning	1	2	
Port Planning and Port Construction	n (L0378)	Lecture	2	2	
Module Responsible	Prof. Peter Fröhle				
Admission Requirements	None				
<b>Recommended Previous</b>	Basics of coastal engineering				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the for	ollowing learning results			
Professional Competence					
Knowledge	The students are able to define in details and to choose design approaches for the functional design of a port and apply the				
	design tasks. They can design the fundamental elements of a port.				
Cl://-					
SKIIIS	The students are able to select and apply appropriate approaches for the functional design of ports.				
Personal Competence					
Social Competence	The students are able to deploy their gained knowledge in applied problems such as the functional design of ports. Additiona				
	they will be able to work in team with engineers of other disciplines.				
Autonomy	The students will be able to independently extend their knowledge and apply it to new problems.				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70				
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	The duration of the examination is 150 min. The examin	ation includes tasks with respect to	the general u	understanding of	
scale	lecture contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Ele	ctive Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Coastal Engineering: Comp	oulsory			
	Civil Engineering: Specialisation Water and Traffic: Elective	Compulsory			
	International Management and Engineering: Specialisation	II. Civil Engineering: Elective Compuls	orv		

	neering
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	SoSe
Content	<ul> <li>Fundamentals of harbor engineering <ul> <li>Maritime transportation and waterways engineering</li> <li>Ships</li> </ul> </li> <li>Elements of harbors <ul> <li>Harbor approaches and water-side harbor areas</li> <li>Terminal design and handling of cargo</li> <li>Quay-walls and piers</li> <li>Equipment of harbors</li> <li>Sluices and other special constructions</li> </ul> </li> <li>Connection to inland transportation / inland waterway transportation</li> <li>Protection of harbors <ul> <li>Breakwaters and Jetties</li> <li>Wave protection of harbors</li> </ul> </li> <li>Fishery and other small harbors</li> </ul>
Literature	Brinkmann, B.: Seehäfen, Springer 2005

Course L1414: Harbour Engi	ourse L1414: Harbour Engineering		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
CP	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	DE		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Frank Feindt
Language	DE
Cycle	SoSe
Content	<ul> <li>Planning and implementation of major projects</li> <li>Market analysis and traffic relations</li> <li>Planning process and plan</li> <li>Port planning in urban neighborhood</li> <li>Development of the logistics center "Port of Hamburg" in the metropolis</li> <li>Quays and waterfront structure</li> <li>Special planning Law Harbor - securing of a flexible use of the port</li> <li>Dimensioning of quays</li> <li>Flood protection structures</li> <li>Port of Hamburg - Infrastructure and development</li> <li>Preparation of areas</li> <li>Scour formation in front of shore structures</li> </ul>
Literature	Vorlesungsumdruck, s. www.tu-harburg.de/gbt

Courses				
			11	
Title Water and Environment (L2754)		<b>Typ</b> Project-/problem-based Learning	Hrs/wk 3	<b>CP</b> 3
Water and Environment (L2753)		Lecture	3	3
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge in water and environmental research, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	wing learning results		
Professional Competence				
Knowledge	Common research tools and techniques together with the fundamental knowledge relevant to multi-scale and multi-phase challenges present in water and environmental research will be discussed in this module. Both theory and application will be considered.			
Skills	In addition to the fundamental knowledge, the students will be exposed to several analytical, experimental and numerical too and techniques relevant to water and environmental research at different scales. This will provide the students with an exceller opportunity to improve their skills on multiple fronts which will be useful in their future career.			
Personal Competence				
Social Competence	Developing teamwork and problem solving skills through Rese	arch-Based Teaching approaches	will be at the c	ore of this module
Autonomy	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability ar willingness to work independently and responsibly.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Report and Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Elective	Compulsory		
Following Curricula	Civil Engineering: Specialisation Water and Traffic: Elective Co	mpulsory		
	Environmental Engineering: Specialisation Environment and Cl	imate: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: El	ective Compulsory		
	Water and Environmental Engineering: Specialisation Water: E	lective Compulsory		
	Water and Environmental Engineering: Specialisation Environn	nent: Compulsory		

Course L2754: Water and En	Course L2754: Water and Environment		
Тур	Project-/problem-based Learning		
Hrs/wk	3		
СР	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Dr. Salome Shokri-Kuehni		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L2753: Water and En	vironment
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	SoSe
Content	Research based learning: The students will be engaged in active research focused on water and environmental related challenges.
	The required knowledge and tools will be discussed during the semester.
Literature	NA

C				
Courses				
Title		Тур	Hrs/wk	СР
Smart Monitoring (L2762) Smart Monitoring (L2763)		Integrated Lecture Recitation Section (small)	2 2	2 4
	Dest Ver Creater	Recitation Section (smail)	Z	+
Module Responsible				
Admission Requirements				
	Basic knowledge or interest in object-oriented mod			
Knowledge				
	skills of scientific working, are required. Basic knowledge in scientific writing and good English skills.			
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
Knowledge	The students will become familiar with the princip	oles and practices of smart monitoring. T	The students wil	l be able to de
	decentralized smart systems to be applied for c	ontinuous (remote) monitoring of syster	ns in the built	and in the nat
	environment. In addition, the students will learn to a			
	analysis techniques, modern software design concer			
	also part of this module, which will be conducted th	nroughout the semester and will contribut	e to the grade.	In small groups,
	students will design smart monitoring systems that i	ntegrate a number of "intelligent" sensors	to be implemen	ted by the stude
	Specific focus will be put on the application of mad	chine learning techniques. The smart mor	itoring systems	will be mounted
	real-world (built or natural) systems, such as bridges	s or slopes, or on scaled lab structures for	validation purpo	ses. The outcom
	every group will be documented in a paper. All stude	ents of this module will "automatically" pa	rticipate with the	eir smart monito
	system in the annual "Smart Monitoring" competitio	n. The written papers and oral examination	ns form the final	grades. The mo
	will be taught in English. Limited enrollment.			
Skills	The students will gain insights into operating state-			
	processes relevant to engineering, such as enviro			
	devising monitoring strategies of physical processe		-	-
	implement the strategies in smart wireless sensor n		ogramming. Final	ly, the students
	be able to document the findings of their projects in	short reports.		
Personal Competence				
	The students will be able to work in groups, share p	parts of the work for their projects, and de	velop communic	ation skills. tow
,	achieving the common project goals.			
Autonomy	The students will be able to gain a solid basis on a	approaching and solving problems in engi	neering, as well	as on documer
	results, through their involvement in their monitoring	g group projects.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	10 pages of work with 15-minute oral presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: E	lective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	eering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering	: Elective Compulsory		
	Civil Engineering: Specialisation Structural Engineeri	ng: Elective Compulsory		
	Computer Science: Specialisation II: Intelligence Eng	ineering: Elective Compulsory		
	Environmental Engineering: Specialisation Energy ar	nd Resources: Elective Compulsory		
	Environmental Engineering: Specialisation Environm			
	Environmental Engineering: Specialisation Water Qu		pulsory	
	Mechatronics: Technical Complementary Course: Ele		-	
	Mechatronics: Core Qualification: Elective Compulso			
	Theoretical Mechanical Engineering: Specialisation R		ompulsory	
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation			

Course L2762: Smart Monito	ring
Тур	Integrated Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	SoSe
Content	In this course, principles of smart monitoring will be taught, focusing on modern concepts of data acquisition, data storage, and data analysis. Also, fundamentals of intelligent sensors and embedded computing will be illuminated. Autonomous software and decentralized data processing are further crucial parts of the course, including concepts of the Internet of Things, Industry 4.0 and cyber-physical systems. Furthermore, measuring principles, data acquisition systems, data management and data analysis algorithms will be discussed. Besides the theoretical background, numerous practical examples will be shown to demonstrate how smart monitoring may advantageously be used for assessing the condition of systems in the built or natural environment.
Literature	The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course. However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online.

ourse L2763: Smart Monito	ring
Тур	Recitation Section (small)
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	SoSe
	The contents of the exercises are based on the lecture contents. In addition to the exercises, project work will be conducted throughout the semester, which will consume the majority of the workload. As part of the project work, students will design smart monitoring systems that will be tested in the laboratory or in the field. As mentioned in the module description, the students will participate in the "Smart Monitoring" competition, hosted annually by the Institute of Digital and Autonomous Construction. Students are encouraged to contribute their own ideas. The tools required to implement the smart monitoring systems will be taught in the group exercises as well as through external sources, such as video tutorials and literature. The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course. However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online.

Courses						
Title			Тур		Hrs/wk	СР
Waste management (L3261)			Proje	ect-/problem-based Learning	3	3
nternational waste concepts (L325	9)		Lectu	ure	2	2
International waste concepts (L326	0) Recitation Section (small) 1 1					1
Module Responsible	Prof. Kerstin Kuchta					
Admission Requirements	None	None				
<b>Recommended Previous</b>	Basics in process enginee	ering				
Knowledge						
Educational Objectives	After taking part successf	fully, students have re	ached the following lea	arning results		
Professional Competence						
Knowledge	The students are able to	describe waste as a i	resource as well as ad	vanced technologies for re	cycling and re	ecovery of resour
	from waste in detail. This	covers collection, trar	nsport, treatment and o	disposal in national and inte	ernational con	texts.
Skille	Skills Students are able to select suitable processes for the treatment with respect to the national or cultural and devel					
381115				fferent technologies and ma		
	They can evaluate the eco			nerent technologies and ma	anagement sy	sterns.
Personal Competence						
Social Competence	Students can work together as a team of 2-5 persons, participate in subject-specific and interdisciplinary discussions, devel					
	cooperated solutions and	l defend their own wo	ork results in front of o	thers and promote the scie	entific develop	oment of colleagu
	Furthermore, they can give	ve and accept professi	ional constructive critic	cisms.		
4	Chudanta ann indenanda.				luine the site	
Autonomy	bomy Students can independently gain additional knowledge of the subject area and apply it in solving the given cour			en course lasks a		
	projects.					
Workload in Hours	Independent Study Time	96, Study Time in Lect	ture 84			
Credit points	6					
Course achievement	Compulsory Bonus Fo	rm	Description			
	Yes 20 % W	ritten elaboration				
Examination	Presentation					
Examination duration and	PowerPoint presentation (	(10-15 minutes)				
scale						
Assignment for the	Civil Engineering: Special	isation Water and Traf	ffic: Elective Compulso	ry		
Following Curricula	Chemical and Bioprocess	Engineering: Specialis	sation General Process	Engineering: Elective Comp	oulsory	
	Chemical and Bioprocess	Engineering: Specialis	sation Bioprocess Engir	neering: Elective Compulsor	У	
	Chemical and Bioprocess	Engineering: Specialis	sation Chemical Proces	s Engineering: Elective Com	npulsory	
	Environmental Engineerin	ng: Specialisation Ener	rgy and Resources: Elec	ctive Compulsory		
	International Managemen	nt and Engineering: Sp	ecialisation II. Renewal	ble Energy: Elective Compu	lsory	
	Process Engineering: Spe	cialisation Environmer	ntal Process Engineerin	g: Elective Compulsory		
	Water and Environmental	Engineering: Speciali	sation Cities: Elective (	Compulsory		
	Water and Environmental	Engineering, Speciali				

Course L3261: Waste manag	ement
Тур	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Rüdiger Siechau
Language	EN
Cycle	SoSe
Content	<ul> <li>Introduction into the "Waste Management" consisting of: <ul> <li>Thermal Process (incinerator, RDF combustion)</li> <li>Biological processes (Wet-/Dryfermentation)</li> <li>technology, energy, emissions, approval, etc.</li> </ul> </li> <li>Group work <ul> <li>design of systems/plants for energy recovery from waste</li> <li>The following points are to be processed: <ul> <li>Input: waste (fraction collection and transportation, current quantity, material flows, possible amount of development)</li> <li>Plant (design, process diagram, technology, energy production)</li> <li>Output (energy quantity / type, by-products)</li> <li>Costs and revenues</li> <li>Climate and resource protection (CO2 balance, substitution of primary raw materials / fossil fuels)</li> <li>Location and approval (infrastructure, expiration authorization procedure)</li> <li>Focus at the whole concept (advantages, disadvantages, risks and opportunities, discussion)</li> </ul> </li> </ul></li></ul>
Literature	Einführung in die Abfallwirtschaft; Martin Kranert, Klaus Cord-Landwehr (Hrsg.); Vieweg + Teubner Verlag; 2010 Powerpoint-Folien in Stud IP

Course L3259: International	waste concepts
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	SoSe
Content	Waste avoidance and recycling are the focus of this lecture. Additionally, waste logistics ( Collection, transport, export, fees and taxes) as well as international waste shipment solutions are presented. Other specific wastes, e.g. industrial waste, treatment concepts will be presented and developed by students themselves Waste composition and production on international level, wast eulogistic, collection and treatment in emerging and developing countries. Single national projects and studies will be prepared and presented by students
Literature	Basel convention

Course L3260: International	ourse L3260: International waste concepts		
Тур	Recitation Section (small)		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Kerstin Kuchta		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses					
Title		Тур	Hrs/wk	СР	
Applied Surface Hydrology (L0289)		Lecture	2	2	
Applied Surface Hydrology (L1412)		Project-/problem-based L	-	2	
nteraction Water - Environment in	1	Project-/problem-based L	earning 1	2	
Module Responsible					
Admission Requirements					
	Fundamentals of Hydromechanics and H	lydraulic Engineering: Hydraulic Engineering I an	d Hydraulic Engineer	ing II	
Knowledge					
Educational Objectives	After taking part successfully, students	have reached the following learning results			
Professional Competence					
Knowledge	The students are able to define the bas	sic concepts of hydrology and water management	nt. They are able to	describe and qua	
	the relevant processes of the hydrologic	cal water cycle. Besides, the students know the r	nain aspects of rainfa	all-run-off-models	
	are able to theoretically derive establish	ed reservoir / storage models and a unit-hydrogr	aph.		
Skills	s The students are able to use the basic hydrological concepts and approaches and are able to theoretically derive establisher				
56115	reservoir / storage models or a unit-hydrograph as the basis for rainfall-run-off-models. The student are able to explain the basis				
		ical and hydrodynamic values in nature and are			
		re, they are able to apply a hydrological model to		-	
	ussess these measurements. Furtherme	re, they are able to apply a hydrological model a	busic injurbiografi p	i obierno.	
Personal Competence					
Social Competence	The students are able to deploy their ga	ined knowledge in applied problems of the hydro	logy and water man	agement. Additior	
	they will be able to work in team with e	ngineers of other disciplines.			
Autonomy	The students will be able to independen	tly extend their knowledge and apply it to new p	roblems		
Workload in Hours	Independent Study Time 124, Study Tin	a in Lecture 56			
Credit points					
Course achievement					
Examination	Written exam				
Examination		in. The examination includes tasks with respect t	the general unders	tanding of the lec	
Examination Examination duration and		in. The examination includes tasks with respect t	to the general unders	tanding of the lec	
Examination Examination duration and scale	The duration of the examination is 90 m contents and calculations tasks.	in. The examination includes tasks with respect t	to the general unders	tanding of the lec	
Examination Examination duration and scale	The duration of the examination is 90 m contents and calculations tasks. Civil Engineering: Specialisation Compu	ational Engineering: Elective Compulsory	to the general unders	tanding of the lec	
Examination Examination duration and scale Assignment for the	The duration of the examination is 90 m contents and calculations tasks. Civil Engineering: Specialisation Compu	tational Engineering: Elective Compulsory and Traffic: Compulsory	to the general unders	tanding of the lec	
Examination Examination duration and scale Assignment for the	The duration of the examination is 90 m contents and calculations tasks. Civil Engineering: Specialisation Compu Civil Engineering: Specialisation Water a Environmental Engineering: Core Qualif	tational Engineering: Elective Compulsory and Traffic: Compulsory		tanding of the lec	
Examination Examination duration and scale Assignment for the	The duration of the examination is 90 m contents and calculations tasks. Civil Engineering: Specialisation Compu Civil Engineering: Specialisation Water a Environmental Engineering: Core Qualif Joint European Master in Environmental	tational Engineering: Elective Compulsory and Traffic: Compulsory cation: Elective Compulsory		tanding of the lec	
Examination Examination duration and scale Assignment for the	The duration of the examination is 90 m contents and calculations tasks. Civil Engineering: Specialisation Compu Civil Engineering: Specialisation Water a Environmental Engineering: Core Qualif Joint European Master in Environmental Water and Environmental Engineering:	tational Engineering: Elective Compulsory and Traffic: Compulsory cation: Elective Compulsory Studies - Cities and Sustainability: Core Qualifica		tanding of the lec	

Course L0289: Applied Surfa	ce Hydrology
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE/EN
Cycle	SoSe
Content	<ul> <li>Basics of hydrology:</li> <li>Hydrological cycle</li> <li>Data acquisition</li> <li>Data analyses and statistical assessment</li> <li>Statistics of extremes</li> <li>Regionalization methods for hydrological values</li> <li>Rainfall-run-off modelling on the basis of a unit hydrograph conceps</li> <li>Application of rainfall-run-off models on the basis of Kalypso-Hydrology which is an OpenSource Software Tool.</li> </ul>
Literature	http://de.wikipedia.org/wiki/Kalypso_(Software) http://kalypso.bjoernsen.de/ http://sourceforge.net/projects/kalypso/

Course L1412: Applied Surfa	rse L1412: Applied Surface Hydrology		
Тур	Project-/problem-based Learning		
Hrs/wk	1		
CP	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Peter Fröhle		
Language	DE/EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0295: Interaction W	ater - Environment in Fluvial Areas
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE/EN
Cycle	SoSe
Content	A problem based learning course. The problem will be solved by the students more or less self-contained. The topics will be introduced and elaborated over the semester.
Literature	-

Courses					
Title		Тур		Hrs/wk	СР
Modeling Processes in Vadose Zone	e (L2735)	Recita	tion Section (small)	2	2
Vadose Zone Hydrology (L2732)		Lectur	e	2	2
Vadose Zone Hydrology (L2733)		Recita	tion Section (large)	2	2
Module Responsible	Prof. Nima Shokri				
Admission Requirements	None				
<b>Recommended Previous</b>	Basic knowledge in water and soil				
Knowledge					
	Comfortable with math and physics, crit	ical thinking, creative problem :	solving		
	Analytic skills				
Educational Objectives	After taking part successfully, students I	nave reached the following lear	ning results		
Professional Competence					
Knowledge	The students will learn about soil cha	aracterization (solid and liquid	f phase), the energy	state of soil w	ater, the soil wa
	characteristic curve, flow in saturated an	nd unsaturated soil as well as a	bout solute transport in	n soil	
Skills	Students will work on practical exam	ples modelling transport proc	esses in soil using c	lifferent quantita	ative tools includ
	s Students will work on practical examples modelling transport processes in soil using different quantitative tools includir computer simulations and analytical tools. This will help them to apply knowledge in order to solve problems and tasks.				
Demonal Competence					
Personal Competence					
Social Competence	The module aims at raising awareness		wledge related to wa	ater, soil and en	ivironment. This
	positively contribute to shape their work	and life environment.			
Autonomy	The students will be involved in ma	ny problem solving exercises	3. This will contribute	e toward their	willingness to w
	independently and responsibly.				
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84			
Credit points	6				
Course achievement	None				
Examination	Written elaboration				
Examination duration and	Report and Presentation				
scale					
Assignment for the	Civil Engineering: Specialisation Comput	ational Engineering: Elective Co	ompulsory		
Following Curricula	Civil Engineering: Specialisation Water a	nd Traffic: Elective Compulsory			
	Environmental Engineering: Core Qualifi	cation: Elective Compulsory			
	Water and Environmental Engineering: 9	Specialisation Water: Elective Co	ompulsory		

Course L2735: Modeling Proc	cesses in Vadose Zone
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Mohammad Aziz Zarif
Language	EN
Cycle	SoSe
Content	Numerical tools will be introduced and used to quantify flow and transport processes in soil
Literature	NA

Course L2732: Vadose Zone	Hydrology
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	SoSe
Content	Soil solid phase characterization, Soil liquid phase characterization, The energy state of soil water, Soil Water Characteristic
	Curve, Flow in saturated soil, Flow in unsaturated soil, Solute transport in porous media
Literature	- Environmental Soil Physics, by Daniel Hillel
	- Soil Physics, Sixth Edition, by William A. Jury and Robert Horton
	- Physical Hydrology, Second Edition, by S. Lawrence Dingman
	- Introduction to Physical Hydrology, by Martin R. Hendriks

Course L2733: Vadose Zone	rse L2733: Vadose Zone Hydrology		
Тур	Recitation Section (large)		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Nima Shokri		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Courses					
Title		Тур	Hrs/wk	СР	
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0942)	Seminar	2	3	
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0941)	Lecture	2	3	
Module Responsible	Prof. Ralf Otterpohl				
Admission Requirements	None				
<b>Recommended Previous</b>	Basic knowledge of the global situation with rising povert	y, soil degradation, lack of v	vater resources and sanit	ation	
Knowledge					
Educational Objectives	After taking part successfully, students have reached the	following learning results			
Professional Competence					
Knowledge	Students can describe resources oriented wastewater s	stems mainly based on so	urce control in detail. Th	iey can comment o	
	techniques designed for reuse of water, nutrients and soi	conditioners.			
	Students are able to discuss a wide range of proven appr	aschos in Rural Dovelopmer	t from and for many road	one of the world	
	Students are able to discuss a wide range of proven appr	baches in Kurai Developiner	it noni and for many regi	ons of the world.	
Skills	Students are able to design low-tech/low-cost sanitation	n, rural water supply, rain	water harvesting system	is, measures for t	
	rehabilitation of top soil quality combined with food and	water security. Students can	consult on the basics of	soil building throu	
	"Holisitc Planned Grazing" as developed by Allan Savory.				
Personal Competence					
	The students are able to develop a specific topic in a tea	n and to work out milestone	s according to a given pl	an	
Social Competence	The students are able to develop a specific topic in a teal		s according to a given pr		
Autonomy	Students are in a position to work on a subject and to	organize their work flow i	ndependently. They can	also present on th	
	subject.				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6				
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and	During the course of the semester, the students work to	wards mile stones. The wor	k includes presentations	and papers. Detail	
scale	information will be provided at the beginning of the smes	ter.			
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Electiv	e Compulsory			
Following Curricula	Bioprocess Engineering: Specialisation A - General Biopro	cess Engineering: Elective C	Compulsory		
	Chemical and Bioprocess Engineering: Specialisation Ger	eral Process Engineering: El	ective Compulsory		
	Environmental Engineering: Specialisation Environment a	nd Climate: Elective Compu	lsory		
	Environmental Engineering: Specialisation Water Quality	and Water Engineering: Elec	tive Compulsory		
	International Management and Engineering: Specialisation	n II. Energy and Environmer	tal Engineering: Elective	Compulsory	
	Process Engineering: Specialisation Environmental Proces	s Engineering: Elective Com	pulsory		
	Process Engineering: Specialisation Process Engineering:	Elective Compulsory			
	Water and Environmental Engineering: Specialisation Wa	er: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Env	ironment: Elective Compuls	ory		

Course L0942: Rural Develop	ment and Resources Oriented Sanitation for different Climate Zones
Тур	Seminar
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	
	<ul> <li>Central part of this module is a group work on a subtopic of the lectures. The focus of these projects will be based on an interview with a target audience, practitioners or scientists.</li> <li>The group work is divided into several Milestones and Assignments. The outcome will be presented in a final presentation at the end of the semester.</li> </ul>
Literature	<ul> <li>J. Lange, R. Otterpohl 2000: Abwasser - Handbuch zu einer zukunftsfähigen Abwasserwirtschaft. Mallbeton Verlag (TUHH Bibliothek)</li> <li>Winblad, Uno and Simpson-Hébert, Mayling 2004: Ecological Sanitation, EcoSanRes, Sweden (free download)</li> <li>Schober, Sabine: WTO/TUHH Award winning Terra Preta Toilet Design: http://youtu.be/w_R09cYq6ys</li> </ul>

Course L0941: Rural Develop	ment and Resources Oriented Sanitation for different Climate Zones
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	<ul> <li>Living Soil - THE key element of Rural Development</li> <li>Participatory Approaches</li> <li>Rainwater Harvesting</li> <li>Ecological Sanitation Principles and practical examples</li> <li>Permaculture Principles of Rural Development</li> <li>Performance and Resilience of Organic Small Farms</li> <li>Going Further: The TUHH Toolbox for Rural Development</li> <li>EMAS Technologies, Low cost drinking water supply</li> </ul>
Literature	<ul> <li>Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation: http://youtu.be/9hmkgn0nBgk</li> <li>Montgomery, David R. 2007: Dirt: The Erosion of Civilizations, University of California Press</li> </ul>

Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater T	reatment (L0522)	Project-/problem-based Learning	2	3
Process Modeling in Drinking Wate	Treatment (L0314)	Project-/problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
<b>Recommended Previous</b>	Knowledge of the most important processes in drinking	water and waste water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	Students are able to explain selected processes of dri	nking water and waste water treatment i	in detail. They	are able to expla
	basics as well as possibilities and limitations of dynamic	modeling.		
Skille	Students are able to use the most important features	Modelica offers. They are able to transpo	so colocted r	racassas in drinki
SKIIIS	Students are able to use the most important features water and waste water treatment into a mathematical			
	They are able to set up and apply models and assess th		mum, kinetics	
Personal Competence				
-	Students are able to solve problems and document solu	itions in a group with members of differe	nt technical h	ackground They a
Social competence	able to give appropriate feedback and can work constru			ackground. They c
Autonomy	Students are able to define a problem, gain the require	d knowledge and set up a model		
Autonomy	students are usie to define a problem, gain the require	a knowledge and set up a model.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec	tive Compulsory		
Following Curricula	Environmental Engineering: Specialisation Water Qualit	y and Water Engineering: Elective Compu	lsory	
	Process Engineering: Specialisation Environmental Proc	ess Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering	: Elective Compulsory		
	Water and Environmental Engineering: Specialisation W	ater: Elective Compulsory		
	Water and Environmental Engineering: Specialisation E	nvironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation C	ties: Elective Compulsory		

Course L0522: Process Mode	lling of Wastewater Treatment
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Joachim Behrendt
Language	DE/EN
Cycle	WiSe
Content	Mass and energy balances
	Tracer modelling
	Activated Sludge Model
	Wastewater Treatment Plant Modelling (continously and SBR)
	Sludge Treatment (ADM, aerobic autothermal)
	Biofilm Modelling
Literature	Henze, Mogens (Seminar on Activated Sludge Modelling, ; Kollekolle Seminar on Activated Sludge Modelling, ;)
	Activated sludge modelling : processes in theory and practice ; selected proceedings of the 5th Kollekolle Seminar on Activated
	Sludge Modelling, held in Kollekolle, Denmark, 10 - 12 September 2001
	ISBN: 1843394146
	[London] : IWA Publ., 2002
	TUB_HH_Katalog
	Henze, Mogens
	Activated sludge models ASM1, ASM2, ASM2d and ASM3
	ISBN: 1900222248
	London : IWA Publ., 2002
	TUB_HH_Katalog
	Henze, Mogens
	Wastewater treatment : biological and chemical processes
	ISBN: 3540422285 (Pp.)
	Berlin [u.a.] : Springer, 2002
	TUB_HH_Katalog
	Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;)
	Fundamentals of biological wastewater treatment
	ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm
	Weinheim : WILEY-VCH, 2007
	TUB_HH_Katalog

Course L0314: Process Mode	ling in Drinking Water Treatment
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Klaus Johannsen
Language	EN
Cycle	WiSe
Content	In this course selected drinking water treatment processes (e.g. aeration or activated carbon adsorption) are modeled dynamically using the programming language Modelica, that is increasingly used in industry. In this course OpenModelica is used, an free access frontend of the programming language Modelica. In the beginning of the course the use of OpenModelica is explainded by means of simple examples. Together required elements and structure of the model are developed. The implementation in OpenModelica and the application of the model is done individually or in groups respectively. Students get feedback and can gain extra points for the exam.
Literature	<ul> <li>OpenModelica: https://openmodelica.org/index.php/download/download-windows</li> <li>OpenModelica - Modelica Tutorial: https://openmodelica.org/index.php/useresresources/userdocumentation</li> <li>OpenModelica - Users Guide: https://openmodelica.org/index.php/useresresources/userdocumentation</li> <li>Peter Fritzson: Principles of Object-Oriented Modeling and Simulation with Modelica 2.1,Wiley-IEEE Press, ISBN 0-471-471631.</li> <li>MHW (rev. by Crittenden, J. et al.): Water treatment principles and design. John Wiley &amp; Sons, Hoboken, 2005.</li> <li>Stumm, W., Morgan, J.J.: Aquatic chemistry. John Wiley &amp; Sons, New York, 1996.</li> <li>DVGW (Hrsg.): Wasseraufbereitung - Grundlagen und Verfahren. Oldenbourg Industrie Verlag, München, 2004.</li> </ul>

	rete Structures	ة 				
Courses						
Fitle			Тур	Hrs/wk	СР	
Concrete Structures (L0579)			Seminar	1	1	
Structural Concrete Members (L05)	77)		Lecture	2	3	
Structural Concrete Members (L05	78)		Recitation Section (large)	2	2	
Module Responsible	NN					
Admission Requirements	None					
<b>Recommended Previous</b>	Basics of structural analysis, conception and dimensioning of structural concrete					
Knowledge						
	Modules: Reinforced	Concrete Structures I+	-II, Structural Analysis I+II, Mechanics I+II			
	After taking part suc	cessfully, students hav	e reached the following learning results			
Professional Competence						
Knowledge			ral engineering, especially in the field of buildin			
	the knowledge for th	e conception and desig	on of concrete buildings and structural member	s that are often used	d.	
Skills	The students are ab	le to apply procedures	of the conception and dimensioning to to prac	tical problems of st	ructural engineeri	
511115			ings and to design them for general action			
			and construction sketches and draw up techni		a chen accumig a	
	execution. Horeover	, they can make design	rand construction sketches and draw up teenin	icul descriptions.		
Personal Competence						
Social Competence	The students are abl	le to obtain results of h	igh quality in teamwork.			
Autonomy	The students are abl	le to carry out complex	conception and dimensioning tasks of structure	es under the quidan	co of tutors	
hatohomy	The statents are us	le to carry out complex		es under the guidant		
	Independent Study T	Fime 110, Study Time in	n Lecture 70			
Workload in Hours						
Workload in Hours Credit points						
	Compulsory Bonus	Form	Description			
Credit points Course achievement	Compulsory Bonus No None	Form Presentation	<b>Description</b> Es werden 2 Referate ausgegeben			
Credit points Course achievement Examination	Compulsory         Bonus           No         None           Written exam		•			
Credit points Course achievement	Compulsory         Bonus           No         None           Written exam		•			
Credit points Course achievement Examination	Compulsory         Bonus           No         None           Written exam		•			
Credit points Course achievement Examination Examination duration and scale	Compulsory         Bonus           No         None           Written exam         120 minutes	Presentation	•			
Credit points Course achievement Examination Examination duration and scale Assignment for the	Compulsory         Bonus           No         None           Written exam         120 minutes           Civil Engineering: Sp	Presentation	Es werden 2 Referate ausgegeben			
Credit points Course achievement Examination Examination duration and scale Assignment for the	Compulsory         Bonus           No         None           Written exam         120 minutes           Civil Engineering: Sp         Civil Engineering: Sp	Presentation pecialisation Structural l pecialisation Geotechnic	Es werden 2 Referate ausgegeben			
Credit points Course achievement Examination Examination duration and scale Assignment for the	Compulsory         Bonus           No         None           Written exam         120 minutes           Civil Engineering: Sp         Civil Engineering: Sp           Civil Engineering: Sp         Civil Engineering: Sp	Presentation pecialisation Structural pecialisation Geotechnic pecialisation Coastal En	Es werden 2 Referate ausgegeben			
Credit points Course achievement Examination Examination duration and scale Assignment for the	Compulsory         Bonus           No         None           Written exam         120 minutes           Civil Engineering: Sp         Civil Engineering: Sp           Civil Engineering: Sp         Civil Engineering: Sp	Presentation pecialisation Structural pecialisation Geotechnic pecialisation Coastal En- pecialisation Water and	Es werden 2 Referate ausgegeben Engineering: Compulsory cal Engineering: Elective Compulsory gineering: Elective Compulsory			

Course L0579: Concrete Stru	ictures
Тур	Seminar
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	NN
Language	DE
Cycle	WiSe
Content	With help of a project teamwork the subjects of the course "Concrete Structures" is practiced, discussed and presented.
Literature	- Projektbezogene Unterlagen werden abgegeben.

Hrsiwk       2         CP       3         Workload in Hours       Independent Study Time 62, Study Time in Lecture 28         Lecturer       NN         Language       DE         Cycle       WiSe         Content       • skyscrapers: structural elements         • actions on structrues       • bracing systems         • design of slabs (line and point supported plates and floor slabs)       • membranes and deep beams         • folded plates and shells       • truss models         • reinforced and prestressed members       Vorlesungsunterlagen können im STUDIP heruntergeladen werden         · Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010       • König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst & Sohn, Berlin 200         • Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005       • Deutscher Ausschuss für Stahlbeton: Hef 600: Erläuterungen zu DIN EN 1992-1-1. Beuth Verlag, Berlin 2012         • Deutscher Ausschuss für Stahlbeton: Hef 240: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen vorstahlbetontragwerken, Verlag Ernst & Sohn, Berlin 1978         • Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalend 1992, Teil 1, 287-366, Verlag Ernst & Sohn, Berlin 1992         • Stiglat/Wippel: Platten. Verlag Ernst & Sohn, Berlin 1992	Түр	Lecture
CP       3         Workload in Hours       Independent Study Time 62, Study Time in Lecture 28         Lecturer       NN         Language       DE         Cycte       WiSe         Content       • skyscrapers: structural elements         • actions on structrues       • bracing systems         • design orf slabs (line and point supported plates and floor slabs)       • membranes and deep beams         • folded plates and shells       • truss models         • reinforced and prestressed members       Vorlesungsunterlagen können im STUDIP heruntergeladen werden         • Zlich K., Zehetmaier G.: Bemessung Im konstruktiven Ingenieurbau. Springer, Heidelberg 2010         • König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst & Sohn, Berlin 200.         • Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005         • Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012         • Deutscher Ausschuss für Stahlbeton: Heft 240: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen vor Stahlbetontragwerken, Verlag Ernst & Sohn, Berlin 1978         • Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalend 1992, Teil 1, 287-366, Verlag Ernst & Sohn, Berlin 1992         • Stiglat/Wippe!: Platten. Verlag Ernst & Sohn, Berlin 1992       Stiglat/Wippel: Platten. Verlag Ernst & Sohn, Berlin 1		
Lecturer         NN           Language         DE           Cycle         WiSe           Content         • skyscrapers: structural elements           • actions on structrues         • bracing systems           • design orf slabs (line and point supported plates and floor slabs)         • membranes and deep beams           • folded plates and shells         • truss models           • truss models         • reinforced and prestressed members           Literature         Vorlesungsunterlagen können im STUDiP heruntergeladen werden           • Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010           • König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst & Sohn, Berlin 200           • Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005           • Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012           • Deutscher Ausschuss für Stahlbeton: Heft 240: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen v. Stahlbetontragwerken, Verlag Ernst & Sohn, Berlin 1978           • Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalend 1992, Teil I, 287-366, Verlag Ernst & Sohn, Berlin 1992           • Stiglat/Wippel: Platten. Verlag Ernst & Sohn, Berlin 1992		
Language         DE           Cycle         WiSe           Content	Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Cycle       WiSe         Content       • skyscrapers: structural elements         • actions on structrues       • bracing systems         • design orf slabs (line and point supported plates and floor slabs)       • membranes and deep beams         • folded plates and shells       • truss models         • reinforced and prestressed members         Literature       Vorlesungsunterlagen können im STUDIP heruntergeladen werden         • Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010         • König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst & Sohn, Berlin 200.         • Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005         • Deutscher Ausschuss für Stahlbeton: Heft 200: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012         • Deutscher Ausschuss für Stahlbeton: Heft 200: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen vo Stahlbetontragwerken, Verlag Ernst & Sohn, Berlin 1978         • Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalend 1992, Teil I, 287-366, Verlag Ernst & Sohn, Berlin 1992         • Stiglat/Wippel: Platten. Verlag Ernst & Sohn, Berlin, 1973	Lecturer	NN
Content       • skyscrapers: structural elements         • actions on structrues       • bracing systems         • design orf slabs (line and point supported plates and floor slabs)         • membranes and deep beams         • folded plates and shells         • truss models         • reinforced and prestressed members         Vorlesungsunterlagen können im STUDiP heruntergeladen werden         • Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010         • König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst & Sohn, Berlin 200.         • Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005         • Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012         • Deutscher Ausschuss für Stahlbeton: Heft 240: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen vor Stahlbetontragwerken, Verlag Ernst & Sohn, Berlin 1978         • Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalend 1992, Teil I, 287-366, Verlag Ernst & Sohn, Berlin 1992         • Stiglat/Wippel: Platten. Verlag Ernst & Sohn, Berlin 1973	Language	DE
<ul> <li>skyscrapers: structural elements</li> <li>actions on structrues</li> <li>bracing systems</li> <li>design orf slabs (line and point supported plates and floor slabs)</li> <li>membranes and deep beams</li> <li>folded plates and shells</li> <li>truss models</li> <li>reinforced and prestressed members</li> </ul> Literature Vorlesungsunterlagen können im STUDiP heruntergeladen werden <ul> <li>Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010</li> <li>König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst &amp; Sohn, Berlin 200</li> <li>Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005 <ul> <li>Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012</li> <li>Deutscher Ausschuss für Stahlbeton: Heft 240: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen vor Stahlbetontragwerken, Verlag Ernst &amp; Sohn, Berlin 1978</li> <li>Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalend 1992, Teil I, 287-366, Verlag Ernst &amp; Sohn, Berlin 1973</li> </ul></li></ul>	Cycle	WiSe
<ul> <li>Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010</li> <li>König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst &amp; Sohn, Berlin 2000</li> <li>Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005</li> <li>Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012</li> <li>Deutscher Ausschuss für Stahlbeton: Heft 240: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen vor Stahlbetontragwerken, Verlag Ernst &amp; Sohn, Berlin 1978</li> <li>Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalend 1992, Teil I, 287-366, Verlag Ernst &amp; Sohn, Berlin 1992</li> <li>Stiglat/Wippel: Platten. Verlag Ernst &amp; Sohn, Berlin, 1973</li> </ul>	Content	<ul> <li>actions on structrues</li> <li>bracing systems</li> <li>design orf slabs (line and point supported plates and floor slabs)</li> <li>membranes and deep beams</li> <li>folded plates and shells</li> <li>truss models</li> </ul>
<ul> <li>Schlaich J.; Schlarer K.: Konstruieren im Stanibetonbau. Betonkalender 1998, Ieli II, S. 721R, Verlag Ernst &amp; Sonn, Berlin 1998</li> </ul>	Literature	<ul> <li>Zilch K., Zehetmaier G.: Bemessung im konstruktiven Ingenieurbau. Springer, Heidelberg 2010</li> <li>König, G., Liphardt S.: Hochhäuser aus Stahlbeton, Betonkalender 2003, Teil II, Seite 1-69, Verlag Ernst &amp; Sohn, Berlin 2003</li> <li>Phocas, Marios C.: Hochhäuser : Tragwerk und Konstruktion, Stuttgart, Teubner, 2005</li> <li>Deutscher Ausschuss für Stahlbeton: Heft 600: Erläuterungen zu DIN EN 1992-1-1, Beuth Verlag, Berlin 2012</li> <li>Deutscher Ausschuss für Stahlbeton: Heft 240: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen vor Stahlbetontragwerken, Verlag Ernst &amp; Sohn, Berlin 1978</li> <li>Stiglat, K., Wippel, H.: Massive Platten - Ausgewählte Kapitel der Schnittkraftermittlung und Bemessung, Betonkalende 1992, Teil I, 287-366, Verlag Ernst &amp; Sohn, Berlin 1992</li> <li>Stiglat/Wippel: Platten. Verlag Ernst &amp; Sohn, Berlin, 1973</li> <li>Schlaich J.; Schäfer K.: Konstruieren im Stahlbetonbau. Betonkalender 1998, Teil II, S. 721ff, Verlag Ernst &amp; Sohn, Berlin, 1973</li> </ul>

Course L0578: Structural Con	ncrete Members
Тур	Recitation Section (large)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	NN
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0963: Steel	and Composite Structures			
Courses				
Title		Тур	Hrs/wk	СР
Steel and Composite Structures (LI	.204)	Lecture	2	2
Steel and Composite Structures (LI	205)	Recitation Section (large)	2	2
Steel Bridges (L1097)		Lecture	2	2
Module Responsible	Prof. Marcus Rutner			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of steel construction (i.e. Steel Structures I and	I II, BUBC)		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	After successful completition, students can			
	<ul> <li>describe the phenomenon of local buckling</li> </ul>			
	<ul> <li>explain warping torsion</li> </ul>			
	<ul> <li>illustrate the behaviour of composite structures</li> </ul>	-		
	<ul> <li>specify the principles in design of composite still</li> </ul>			
	<ul> <li>sketch the contructions of steel and composite</li> </ul>	bridges		
Skills	After successful participation students are able to			
	<ul> <li>check stiffened and unstiffened plated structure</li> </ul>	es		
	<ul> <li>recognize and verify warping tosion in strucure</li> </ul>	S		
	<ul> <li>design composite structures</li> </ul>			
	<ul> <li>design bridges and o perform the detailing</li> </ul>			
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84	1		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineerin	g: Compulsory		
Following Curricula				
	Civil Engineering: Specialisation Coastal Engineering:			
	Civil Engineering: Specialisation Water and Traffic: Ele			
	Civil Engineering: Specialisation Computational Engine			
	International Management and Engineering: Specialise		oulsory	
	incentational management and Engineering. Specialis	action in crim Engineering. Liective Comp	, ai 301 y	

Course L1204: Steel and Con	nposite Structures
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	WiSe
Content	<ul> <li>Local-buckling of plated structures</li> <li>Warping torsion</li> <li>Composite-girders, -columns, -slabs, -bridges</li> <li>Principles in composite constructions</li> <li>Bridge-design and -construction</li> </ul>
Literature	Petersen, C.: Stahlbau, 4.Auflage 2013, Springer-Vieweg Verlag Minnert, J. Wagenknecht, G.: Verbundbau-Praxis - Berechnung und Konstruktion nach Eurocode 4, 2.Auflage 2013, Bauwerk Beuth Verlag

Course L1205: Steel and Con	ourse L1205: Steel and Composite Structures	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Marcus Rutner	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1097: Steel Bridges	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Yves Freundt
Language	
Cycle	
Content	Lecture Contents ,Steel Bridge Construction
	DrIng. Jörg Ahlgrimm
	- From tendering and contracting to completion - the development of a steel bridge
	- Contents of a bridge static - structural details, examples of analysis in detail:
	-> effective width in regard to the longitudinal stiffeners
	-> Bearing point, bearing stiffener
	-> Crossbeam breakthrough, crossbeam reinforcement
	-> Analysis of the Rib-to-Floorbeam (RF) connection (web-tooth of the floorbeam between trapezoidal shaped Ribs)
	- Steel grades, -designation, testing methods and approval certificates
	- Nondestructive weld inspecting
	- Corrosion protection
	- Bridge bearing - types, format, function, dimensioning, installation
	- Expansion Joints
	- Oscillation of bridge hangers and cables - oscillation damper
	- Opening bridges- Detailed reviews to different assembling procedures and - implements
	- Selective damage events
	Requirements: Basic knowledge in the calculation, dimensioning, and construction of structural elements and joints of constructional steelwork
Literature	
	Herbert Schmidt, Ulrich Schulte, Rainer Zwätz, Lothar Bär:     Ausführung von Stahlbauten
	Petersen, Christian: Stahlbau, Abschnitt Brückenbau
	<ul> <li>Ahlgrimm, J., Lohrer, I.: Erneuerung der Eisenbahnüberführung in Fulda-Horas über die Fulda, Stahlbau 74 (2005), Heft 2, S. 114</li> </ul>

Courses				
Title		Тур	Hrs/wk	СР
Numerical Methods in Geotechnics	(L0375)	Lecture	3	3
Advanced Foundation Engineering		Lecture	2	2
Advanced Foundation Engineering	(L0498)	Recitation Section (large)	1	1
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
<b>Recommended Previous</b>	Geotechnics I and II, Mathematics I-III			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	After successfully completing the module, students w	ill be able to		
	describe individual procedures for the geotech	nical monitoring of civil engineering mea	sures	
	<ul> <li>reproduce exploration and investigation method</li> </ul>		1501 C5,	
	<ul> <li>select suitable types of field and laboratory test</li> </ul>		their results.	
	<ul> <li>state the differences between various stress a</li> </ul>	-		variants of the stre
	and distortion tensor,		<b>y</b>	
	<ul> <li>outline the standard and special soil mechanic</li> </ul>	s tests used to determine the stress-stra	in behavior of soi	il,
	<ul> <li>describe continuum models and the resulting boundary value problems,</li> </ul>			
	as well as define boundary value problems from the field of geotechnical engineering in such a way that they can be		it they can be solv	
	unambiguously.			
o				
Skills	Students will be able to			
	dimension vertical drains for soil improvement	of soft soils,		
	calculate depth compaction using various appl	opriate methods,		
	<ul> <li>apply principles of horizontal bearing capacity</li> </ul>	of piles,		
	<ul> <li>verify the internal and external stability of fluid</li> </ul>	l-supported diaphragm walls,		
	<ul> <li>evaluate the boundary conditions for the d</li> </ul>	esign of a deep excavation and desig	n the individual	components of t
	excavation,			
	<ul> <li>perform, evaluate and interpret tests for the d</li> </ul>	escription and classification of soils acco	rding to applicabl	e standards,
	<ul> <li>computationally implement numerical algorith</li> </ul>	ms to solve boundary value problems,		
	<ul> <li>select and apply the types of analyses depend</li> </ul>	ing on the degree of saturation, the impa	act, and the mate	rial behavior
	<ul> <li>determine appropriate model parameters for one of the second secon</li></ul>	lifferent possibilities and limitations of m	naterial models fo	or the grain structu
	of soils.			
Personal Competence				
	Students can work in groups and support each other	in finding solutions		
Social competence				
Autonomy	Students are able to assess their own strengths and	veaknesses and, based on this, organize	their time and le	arning manageme
	and think in terms of processes.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	4		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering	a: Compulsory		
Following Curricula	Civil Engineering: Specialisation Scretchical Engineering			
string each found	Civil Engineering: Specialisation Coastal Engineering:			
	Civil Engineering: Specialisation Water and Traffic: El			
	Civil Engineering: Specialisation Computational Engin			
	International Management and Engineering: Specialis			

Course L0375: Numerical Me	thods in Geotechnics
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Hans Mathäus Stanford
Language	DE
Cycle	WiSe
Content	Topics:
	<ul> <li>Introduction to numerical soil mechanics</li> <li>Introduction to numerical mathematics</li> <li>Finite Element Method (analysis procedures, algorithms)</li> <li>Finite Element Method (application in geotechnical engineering)</li> </ul>
Literature	<ul> <li>Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden. Springer</li> <li>Wriggers P. (2008): Nonlinear Finite Element Methods. Springer</li> <li>Deutsche Gesellschaft für Geotechnik e.V. (Hrsg., 2014): Empfehlungen des Arbeitskreises "Numerik in der Geotechnik". Ernst &amp; Sohn</li> </ul>

Course L0497: Advanced Fou	Indation Engineering
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	<ul> <li>Vertical drains</li> <li>Piles</li> <li>Ground improvement (Deep Compaction, Soil mixing)</li> <li>Vibration driving</li> <li>Jet grouting</li> <li>Slurry wall</li> <li>Deep excavation</li> </ul>
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>EAB (1988): Empfehlungen des Arbeitskreises Baugruben</li> <li>Grundbau-Taschenbuch, Teil 1-3, (1997), Ernst &amp; Sohn Verlag</li> </ul>

Course L0498: Advanced Fou	ourse L0498: Advanced Foundation Engineering	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Jürgen Grabe	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses	
Title	Typ Hrs/wk CP
Module Responsible	Dozenten des SD B
Admission Requirements	None
Recommended Previous Knowledge	Subjects of the Water Management and Waste specialisation.
Educational Objectives	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
Knowledge	The students are able to demonstrate their detailed knowledge in the field of water management and waste. They can exempli the state of technology and application and discuss critically in the context of actual problems and general conditions of scien and society. The students can develop solving strategies and approaches for fundamental and practical problems in the field of wat management and waste. They may apply theory based procedures and integrate safety-related, ecological, ethical, and econom view points of science and society. Scientific work techniques that are used can be described and critically reviewed.
Skills	The students are able to independently select methods or planning approaches for the project work and to justify their choic They can explain how these methods or approaches relate to solutions in the field of work and how the context of application h to be adjusted. General findings and further developments may essentially be outlined.
Personal Competence	
Social Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems f the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to the colleagues.
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the give deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedbac from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0
Credit points	6
Course achievement	None
Examination	Study work
Examination duration and scale	See FSPO
Assignment for the Following Curricula	Civil Engineering: Specialisation Water and Traffic: Compulsory

Module M0802: Memb	orane Technology			
Courses				
Title		Тур	Hrs/wk	СР
Membrane Technology (L0399)		Lecture	2	3
Membrane Technology (L0400)		Recitation Section (small)	1	2
Membrane Technology (L0401)		Practical Course	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge of water chemistry. Knowledge of the core processes involved in water, gas and steam treatment			
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	Students will be able to rank the technical applications of industrially important membrane processes. They will be able to expla			
	the different driving forces behind existing n	nembrane separation processes. Students w	ill be able to nar	me materials used
	membrane filtration and their advantages and	d disadvantages. Students will be able to ex	plain the key diffe	erences in the use
	membranes in water, other liquid media, gases	s and in liquid/gas mixtures.		
Chille	Students will be able to propage mathematics	al aquations for material transport in persus	and colution diffu	cian mambranac at
3K1115	Students will be able to prepare mathematical equations for material transport in porous and solution-diffusion membranes calculate key parameters in the membrane separation process. They will be able to handle technical membrane processes us			
	available boundary data and provide recomm			
			•	5
	experiments, students will be able to classi			
	membrane materials. Students will be able to o measures to control this.		In uniferent water	is and apply technic
Personal Competence				
Social Competence	Students will be able to work in diverse teams on tasks in the field of membrane technology. They will be able to make decision			
	within their group on laboratory experiments t	o be undertaken jointly and present these to	others.	
A 1				
Autonomy	Students will be in a position to solve homev		ndependently. The	ey will be capable
	finding creative solutions to technical question	S.		
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Tra	ffic: Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - Gen	eral Bioprocess Engineering: Elective Compul	sory	
	Bioprocess Engineering: Specialisation B - Indu	strial Bioprocess Engineering: Elective Comp	lsory	
	Chemical and Bioprocess Engineering: Speciali	sation Chemical Process Engineering: Elective	e Compulsory	
	Chemical and Bioprocess Engineering: Speciali	sation General Process Engineering: Elective	Compulsory	
	Environmental Engineering: Specialisation Wat	er Quality and Water Engineering: Elective Co	ompulsory	
	Process Engineering: Specialisation Process En	gineering: Elective Compulsory		
	Process Engineering: Specialisation Environme	ntal Process Engineering: Elective Compulsor	ý	
	Water and Environmental Engineering: Special	isation Water: Elective Compulsory		
	Water and Environmental Engineering: Special			
		. ,		

Course L0399: Membrane Technology		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Mathias Ernst	
Language	EN	
Cycle	WiSe	
	The lecture on membrane technology supply provides students with a broad understanding of existing membrane treatment processes, encompassing pressure driven membrane processes, membrane application in electrodialyis, pervaporation as well as membrane distillation. The lectures main focus is the industrial production of drinking water like particle separation or desalination; however gas separation processes as well as specific wastewater oriented applications such as membrane bioreactor systems will be discussed as well. Initially, basics in low pressure and high pressure membrane applications are presented (microfiltration, ultrafiltration, nanofiltration, reverse osmosis). Students learn about essential water quality parameter, transport equations and key parameter for pore membrane as well as solution diffusion membrane systems. The lecture sets a specific focus on fouling and scaling issues and provides knowledge on methods how to tackle with these phenomena in real water treatment application. A further part of the lecture deals with the character and manufacturing of different membrane materials and the characterization of membrane material by simple methods and advanced analysis. The functions, advantages and drawbacks of different membrane housings and modules are explained. Students learn how an industrial membrane application is designed in the succession of treatment steps like pre-treatment, water conditioning, membrane integration and post-treatment of water. Besides theory, the students will be provided with knowledge on membrane demo-site examples and insights in industrial practice.	
Literature	<ul> <li>T. Melin, R. Rautenbach: Membranverfahren: Grundlagen der Modul- und Anlagenauslegung (2., erweiterte Auflage), Springer-Verlag, Berlin 2004.</li> <li>Marcel Mulder, Basic Principles of Membrane Technology, Kluwer Academic Publishers, Dordrecht, The Netherlands</li> <li>Richard W. Baker, Membrane Technology and Applications, Second Edition, John Wiley &amp; Sons, Ltd., 2004</li> </ul>	

ourse L0400: Membrane Technology		
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Mathias Ernst	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0401: Membrane Technology		
Тур	Practical Course	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Mathias Ernst	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Courses				
Title		Тур	Hrs/wk	СР
Water Protection and Wastewater Management (L0226)		Lecture	3	3
Water Protection and Wastewater		Project Seminar	3	3
Module Responsible				
Admission Requirements	None			
Recommended Previous	<ul> <li>Basic knowledge in water management;</li> </ul>			
Knowledge	<ul> <li>Good knowledge in urban drainage;</li> </ul>			
	Good knowledge of wastewater treatment	techniques;		
	<ul> <li>Good knowledge of pollutants (e.g. COD, B</li> </ul>	OD, TS, N, P) and their properties;		
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence	After taking part successiony, students have read	the following learning results		
	The students can describe the basic principles of	the regulatory framework related to the	e international and Eu	Iropean water secto
	They can explain limnological processes, substa			
	problems related to water protection, such as e			
	solutions, remediation measures as well as conce	ptual approaches.		
Skills	Students can accurately assess current problems	and cituations in a country specific or	local contaxt. Thou	con suggest concre
SKIIIS	actions to contribute to the planning of tomorr			
	administrative and legislative solutions to solve th		they can suggest a	ppropriate tecrimica
		lese problems.		
Personal Competence				
Social Competence	The students can work together in international g	roups.		
Autonomy	Students are able to organize their work flow to	prepare presentations and discussions	They can acquire ar	propriate knowledg
hatohomy	by making enquiries independently.		They can acquire ap	
Workload in Hours	Independent Study Time 96, Study Time in Lectur	e 84		
Credit points	6			
Course achievement	None			
Examination	Presentation			
	Term paper plus presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engine	ering: Elective Compulsory		
Following Curricula		• • • •		
	Civil Engineering: Specialisation Coastal Engineer	ing: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic	: Elective Compulsory		
	Environmental Engineering: Specialisation Water	Quality and Water Engineering: Elective	e Compulsory	
	International Management and Engineering: Spec	ialisation II. Civil Engineering: Elective (	Compulsory	
	Water and Environmental Engineering: Specialisa	tion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Water: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Environment: Compulsory		

Course L0226: Water Protect	tion and Wastewater Management
Тур	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	<ul> <li>The lecture focusses on:</li> <li>Regulatory Framework (e.g. WFD)</li> <li>Main instruments for the water management and protection</li> <li>In depth knowledge of relevant measures of water pollution control</li> <li>Urban drainage, treatment options in different regions on the world</li> <li>Rainwater management, improved management of heavy rainfalls, downpours, rainwater harvesting, rainwater infiltration</li> <li>Case Studies and Field Trips</li> </ul>
Literature	<ul> <li>The literature listed below is available in the library of the TUHH.</li> <li>Water and wastewater technology Hammer, M. J. 1., &amp; . (2012). (7. ed., internat. ed.). Boston [u.a.]: Pearson Education International.</li> <li>Water and wastewater engineering : design principles and practice: Davis, M. L. 1. (2011) New York, NY: McGraw-Hill.</li> <li>Biological wastewater treatment: (2011). C. P. Leslie Grady, Jr. (3. ed.). London, Boca Raton, Fla. [u.a.]: IWA Publ.</li> </ul>

Course L2008: Water Protection and Wastewater Management		
Тур	Project Seminar	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	WiSe	
Content		
Literature		

Module M1720: Emer	ging Trends in Environmen	tal Engineering			
Courses					
Title		Тур	Hrs/wk	СР	
Environmental Research Trends (L	2752)	Seminar	2	2	
Microplastics in Environment (L275	0)	Lecture	2	2	
Scientific Communication and Meth	ods (L2751)	Lecture	1	2	
Module Responsible	Prof. Nima Shokri				
Admission Requirements	None				
<b>Recommended Previous</b>	Basic knowledge on water, soil and env	vironmental research.			
Knowledge					
Educational Objectives	After taking part successfully, students	have reached the following learning results			
Professional Competence					
Knowledge	The students will be exposed to up-to-date research topics focused on soil, water and climate related challenges with a particul				
	focus on the effects of microplastics i	n environment. Data analysis, data measureme	ent, curation and prese	ntation will be of	
	skills that the students will develop in t	this module.			
Skills	5 Students' research skills will be improved in this module. How to prepare and deliver an effective presentation, how to write a				
	abstract, research paper and proposal will be discussed in this module. Moreover, through Research-Based Learning approache				
	the students will be exposed to current research trends in environmental engineering.				
Personal Competence					
Social Competence	Developing teamwork and problem sol	ving skills through Research-Based Teaching app	proaches will be at the o	core of this modu	
Autonomy	The students will be involved in writ	ing individual reports and presentation. This	will contribute to the	students' ability	
Autonomy	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability a willingness to work independently and responsibly.				
	winingness to work independently and				
Workload in Hours	Independent Study Time 110, Study Ti	me in Lecture 70			
Credit points	6				
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and	Report and Presentation				
scale					
Assignment for the	Civil Engineering: Specialisation Water	and Traffic: Elective Compulsory			
Following Curricula	Environmental Engineering: Specialisat	tion Environment and Climate: Elective Compuls	ory		
	Water and Environmental Engineering:	Specialisation Cities: Elective Compulsory			
	Water and Environmental Engineering:	Specialisation Environment: Elective Compulsor	у		

Course L2752: Environmenta	I Research Trends	
Тур	Seminar	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Salome Shokri-Kuehni	
Language	EN	
Cycle	WiSe	
Content	Introduction - course objectives, expectations and format	
	Analyzing the Audience, purpose and occasion	
	Constructing and delivering effective technical presentations	
	How to write an abstract	
	How to write a scientific paper	
	Developing competitive and persuasive research proposals	
	Databases and resources available for water and environmental research	
	Individual proposal on water and environmental research	
	Individual project on water and environmental research	
	Presentation on water and environmental research	
Literature	<ul> <li>The Craft of Scientific Writing Fourth edition Author: Michael Alley Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9</li> <li>Supplemental materials and web links which will be available to registered students.</li> </ul>	

Course L2750: Microplastics	in Environment
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	- Introduction, objectives, expectations, format, importance
	- Sources of microplastics in environment
	- Microplastics sampling; Characterization of microplastics
	- Distribution of microplastics in terrestrial environments
	- Fate of microplastics in terrestrial environments
	- Project discussion
	- Effects of microplastics on terrestrial environments
	- Health risks of microplastics in environments
	- Project presentations by all students
Literature	- Microplastics in Terrestrial Environments (2021), Edited by Defu He and Yongming Luo
	- Particulate Plastics in Terrestrial and Aquatic Environments (2020), Edited by Nanthi S. Bolan et al.
	- Microplastic Pollutants (2017), by Christopher B. Crawford and Brian Quinn

Тур	Lecture
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	Introduction - course objectives, expectations and format
	Analyzing the Audience, purpose and occasion
	Constructing and delivering effective technical presentations
	How to write an abstract
	How to create a scientific poster
	How to write a scientific paper
	Developing competitive and persuasive research proposals
	Individual project (report and presentation) related to soil, water and environmental research
Literature	The Craft of Scientific Writing Fourth edition
	Author: Michael Alley
	Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9
	<ul> <li>Supplemental materials and web links which will be available to registered students.</li> </ul>

Courses	
<b>Title</b> Adaptation to climate change in hy	Typ     Hrs/wk     CP       draulic engineering (L2291)     Project-/problem-based Learning     4     6
Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	<ul> <li>Hydrology, Hydraulic Engineering</li> <li>Hydromechanic, Hydraulics</li> <li>Fundamentals of Coastal Engineering, Coastal- and Flood Protection</li> <li>Hydrological Systems</li> </ul>
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence Knowledge Skills	<ul> <li>Climate protection and climate adaptation</li> <li>Insights into climate change and its regional characteristics - fundamentals, climate modelling / climate models</li> <li>Impacts of climate change on the components of the regional hydrological cycle</li> <li>Fundamentals of analysis of climate data</li> <li>Consequences of the impact of the climate change</li> <li>Measures for climate adaptation</li> <li>Assessment, prioritization and communication of adaptation measures</li> <li>Fundamentals of the analysis of hydrometeorological and hydrological data</li> </ul>
<b>Personal Competence</b> <i>Social Competence</i> <i>Autonomy</i>	<ul> <li>Working in heterogenous groups</li> <li>Working with different scientific / non-scientific disciplines</li> <li>Self reflection</li> </ul>
	Application oriented use of knowledge and skills
	Autonomous work on complex tasks
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
scale	Preparation of a written report and a presentation of a complex task. Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
Following Curricula	
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory

Course L2291: Adaptation to	o climate change in hydraulic engineering
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	<ul> <li>Climate protection and climate adaptation</li> <li>Findings on climate change and its regional characteristics: fundamentals of climate change, climate modelling / climate models</li> <li>Impacts of climate change on the components of the regional hydrological cycle(climate science view)</li> <li>Fundamentals of the analysis of climate data</li> <li>Concequences of the impacts of climate change (ingenieering science view)</li> <li>Measures for climate change adaptation</li> <li>Assessment, prioritization and communication of measures</li> <li>Fundamentals of analysis of hydrometeorological and hydrological data</li> </ul>
Literature	<ul> <li>Wird bereitgestellt über die HOOU - eLearning Plattform</li> <li>abhängig von den jeweils schwerpunktmäßig behandelten Fragestellungen wird das Schrifttum (aktuelle Paper) in der Veranstaltung bzw. über StudIP zur Verfügung gestellt.</li> </ul>

Courses				
Title		Тур	Hrs/wk	СР
Scientific Working in Computationa	Engineering (L2764)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge in scientific writing. String interest in to	pics related to computing in civil engine	ering.	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Skills	course instructors and in collaboration with each other, the students will also learn to understand the complex process of scientific thinking, being able to accurately plan, implement and analyze scientific projects, such as prospective master theses. A project will be conducted throughout the semester, which will contribute to the grade. Since scientific writing is of particular importance is this course, a scientific paper will be developed based, which is a prerequisite for the final examination. The paper will be writter based on the project conducted within this course. Project meetings in small groups, presentations, and critical discussions of scientific publications are further key activities. The students will be capable (i) of solving a scientific problem following a scientific methodology, (ii) of documenting their work effectively in the form of a paper, and (iii) of sharing their work in a presentation.			
Personal Competence				an ha an an h-imre
Social Competence	The students will be able to work in a multidisciplinary te	am and develop communication skills no	ecessary for p	oblem solving.
Autonomy	The students will be able to extend their knowledge and	apply it to solve scientific problems by w	orking indepe	ndently in a proje
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	10 pages of work with 15-minute oral presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	g: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Ele	ctive Compulsory		
	Civil Engineering: Specialisation Structural Engineering: E	lective Compulsory		
	Civil Engineering: Specialisation Computational Engineeri	ng: Elective Compulsory		
	Computer Science: Specialisation II: Intelligence Engineer	ing: Elective Compulson		

Course L2764: Scientific Wor	rking in Computational Engineering
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	WiSe/SoSe
Content	In the course, a scientific problem of practical relevance will first be defined, taking into account the interests of the students participating in the course. The scientific problem will then systematically be solved within the framework of a comprehensive project. The principles of scientific working will be taught based on the scientific problem defined previously. As an integral part of scientific working, fundamentals of scientific writing will be presented and applied to a scientific paper to be written during the course. Topics related to scientific writing include structuring in scientific writing (structuring the abstract, the introduction, the main part, the summary and conclusions, and the acknowledgments and references) and recommendations on effective scientific writing (principles of composition, use of English in scientific writing, useful tips, creating figures, writing in mathematics, referencing, and formal email correspondence). A final paper and a final presentation will be assembled by the students.
Literature	Smarsly, K. & Dragos, K., 2019. Scientific Writing in Engineering. Tredition, Hamburg, Germany.

## Module M0969: Selected Topics in Civil Engineering

Courses					
Title		Тур	Hrs/wk	СР	
Design of Composite Bridges (L3092)		Integrated Lecture	2	3	
Analysis of Offshore Structures (L1867)		Lecture	1	1	
Energy Geotechnics (L3227)	-		3	3	
Solid Matter Process Technology fo	r Biomass (L0052)	Lecture	2	3	
Forum I - Geotechnics and Constru-	ction Management (L1634)	Seminar	1	1	
Forum II - Geotechnics and Constru	ction Management (L1635)	Seminar	1	1	
Timber Structures (L1151)		Seminar	2	2	
Innovative Timber Construction (L2	666)	Lecture	2	4	
Glass Structures (L1152)		Lecture	2	2	
Glass Structures (L1447)		Recitation Section (large)	1	1	
Sustainable landfill design and ope	ration (L3270)	Integrated Lecture	3	3	
Special Topics in Steel Design (L30	91)	Integrated Lecture	2	3	
Special topics of civil engineering 1	CP (L2378)		1	1	
Special topics of civil engineering 2	2 LP (L2379)		2	2	
Special topics of civil engineering 3	3 LP (L2380)		3	3	
Structural Design (L2789)		Seminar	2	2	
Module Responsible	Prof. Frank Schmidt-Döhl				
Admission Requirements	None				
Recommended Previous	none				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge					
_	Students are able to find their way through selected special areas within civil and structural engineering.				
	• Students are able to explain basic models and procedures in selected special areas of civil and structural engineering.				
	<ul> <li>Students are able to interrelate scientific and</li> </ul>	technical knowledge.			
Skills	Students are able to apply basic methods in selected areas of civil and structural engineering.				
Personal Competence					
Social Competence					
Autonomy					
Autonomy	<ul> <li>Students can chose independently, in which fields they want to deepen their knowledge and skills through the election courses.</li> </ul>				
Workload in Hours	Depends on choice of courses				
Credit points	6				
Assignment for the	Civil Engineering: Specialisation Structural Engineeri	ing: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	eering: Elective Compulsory			
_	Civil Engineering: Specialisation Coastal Engineering	: Elective Compulsory			
	Civil Engineering: Specialisation Water and Traffic: E				
	Civil Engineering: Specialisation Computational Engineering				
	civit Engineering, specialisation computational Engi	neering. Liective compuisory			

Course L3092: Design of Composite Bridges	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	
Literature	

Tvp	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
	Dr. Said Fawad Mohammadi
Language	
Cycle	
Content	Topic 1: Types of Offshore Structures, Fixed and floating structures for Oil & Gas and Offshore Wind industry
	Topic 2: Wave Forces, Morisons equation
	Topic 3: Irregular Seastates, Power spectrum and application of FFT
	Topic 4: Additional Environmental Forces, wind spectra, current forces
	Topic 5: Linear-Time-Invariant Systems, response of an LTI-system in frequency domain
	Topic 6: Tubular Welded Connections, stress concentration factors, weld geometry
	Topic 7: Introduction to Fracture Mechanics, criteria for fracture initiation and crack growth
	Topic 8: Time and Frequency Domain Fatigue Analyses, rainflow counting, application of LTI-systems for frequency domain fatigu
	Topic 9: Offshore Installation and Exam, installation of structures, pile driving, pipe laying techniques
Literature	Chakrabarti, Handbook of Offshore Engineering, 2005
	Sarpkaya, Wave Forces on Offshore Structures, 2010
	Faltinsen, Sea Loads on Ships and Offshore Structures, 1998
	Sorensen, Basic Coastal Engineering, 2006
	Dowling, Mechanical Behavior of Materials, 2007
	Haibach, Betriebsfestigkeit, 2006
	Marshall, Design of Welded Tubular Connections, 1992
	Newland, Random vibrations, spectral and wavelet analysis, 1993

Course L3227: Energy Geotechnics	
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Schriftliche Ausarbeitung (laut FPrO)
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt
scale	
Lecturer	Pauline Kaminski
Language	DE/EN
Cycle	WiSe
Content	Energy geotechnics is a young field in geotechnical engineering with the aim of developing sustainable geotechnical solutions for future-oriented issues relating to the production, transport, operation, decommissioning, and waste utilisation of various energy sources. Examples of possible fields of activity in energy geotechnics include geothermal energy and thermally activated foundation components, foundations for onshore and offshore wind turbines, the decommissioning of mining facilities and the handling of waste products from fossil fuels such as tailings and the geological storage of CO2. Relevant soil mechanical processes in these applications include the thermo-hydro-mechanically coupled behaviour of soils, multiphase flow in porous media and partially saturated soils. The lecture gives an overview of various aspects of energy geotechnics and provides in-depth knowledge of the associated soil mechanical processes. In addition, CO2-scarce geotechnical applications are discussed and emission estimates as well as the optimisation of geotechnical structures according to sustainability aspects are addressed.
Literature	

Course L0052: Solid Matter F	Process Technology for Biomass
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Prof. Werner Sitzmann
Language	DE
Cycle	SoSe
Content	The industrial application of unit operations as part of process engineering is explained by actual examples of solid biomass
	processes. Size reduction, transportation and dosing, drying and agglomeration of renewable resources are described as important
	unit operations when producing solid fuels and bioethanol, producing and refining edible oils, when making Btl - and WPC -
	products. Aspects of explosion protection and plant design complete the lecture.
Literature	Kaltschmitt M., Hartmann H. (Hrsg.): Energie aus Bioamsse, Springer Verlag, 2001, ISBN 3-540-64853-4
	Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz, Schriftenreihe Nachwachsende Rohstoffe,
	Fachagentur Nachwachsende Rohstoffe e.V. www.nachwachsende-rohstoffe.de
	Bockisch M.: Nahrungsfette und -öle, Ulmer Verlag, 1993, ISBN 380000158175

Course L1634: Forum I - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1635: Forum II - Geotechnics and Construction Management	
Тур	Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	30 min
scale	
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	Lectures about projects and issues with practical and scientific relevance.
Literature	

Course L1151: Timber Structures	
Тур	Seminar
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and	90 min
scale	
Lecturer	Prof. Torsten Faber
Language	DE
Cycle	WiSe
Content	
Literature	

Course L2666: Innovative Timber Construction	
Тур	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and	45 Minuten
scale	
Lecturer	Dr. Andreas Meisel
Language	DE
Cycle	WiSe
Content	
Literature	- Blass, J.: "Ingenieurholzbau"
	- Schickhofer, G.: "BSPhandbuch: Holz-Massivbauweise in Brettsperrholz"
	- Informationsdienst Holz: div. Merkblätter und Broschüren
	- Wallner-Novak M.: Brettsperrholz Bemessung, Band 1 und 2
	- Gerner M.: "Fachwerk: Entwicklung, Instandsetzung, Neubau"
	- Meisel, A.: "Historische Dachwerke: Beurteilung, realitätsnahe statische Analyse und Instandsetzung"
	- Kempe K.: "Dokumentation Holzschädlinge"
	- Huckfeldt T.: "Hausfäule- und Bauholzpilze"

Course L1152: Glass Structures	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	DE
Cycle	WiSe
Content	Glass structures
	- Introduction of the material glass (production, refinement, material characteristic)
	- design of facades
	- facade types
	- static calculation of glazing
	- static calculation of facades
	- load bearing behavior of glazing (plate or membrane stiffness)
	- vertical / horizontal glazing with safety-related requirements
	- glass structures
	- fire safety of glass facades
	- construction physics of facades and glazing
Literature	

Course L1447: Glass Structures	
Тур	Recitation Section (large)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and	
scale	
Lecturer	Marvin Matzik
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L3270: Sustainable la	andfill design and operation
Тур	Integrated Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Dr. Marco Ritzkowski
Language	EN
Cycle	SoSe
Content	The course introduces the development of modern waste resource management and demonstrates the importance of landfills in the context of recycling processes. Based on international (EU) and national legislation, the current landfill situation is presented and the future significance of landfills will be discussed. A central element of the course deals with the main transformation processes in the landfilled waste, the emission of gases and leachate, the long-term behaviour of landfills as well as aftercare and after-utilisation measures. Further focal points of the course are measures for the sustainable reduction of environmentally and climate-damaging emissions and aspects of landfill technology in an international context.
Literature	<ol> <li>Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105, Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305</li> <li>Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332</li> <li>Solid Waste Landfilling - Concepts, Processes, Technologies. Cossu, R. and Stegmann, R. (Eds.), ISBN: 978-0-12-818336-6</li> <li>PDF (Volltext) über TUB</li> </ol>

Course L3091: Special Topics in Steel Design	
Тур	Integrated Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	90 min
scale	
Lecturer	Prof. Marcus Rutner, Nikolay Lalkovski
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2378: Special topics	ourse L2378: Special topics of civil engineering 1CP	
Тур		
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Examination Form	Fachtheoretisch-fachpraktische Arbeit	
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt	
scale		
Lecturer	Dozenten des SD B	
Language	DE	
Cycle	WiSe/SoSe	
Content	The course occurs only if required. The content is defined at short notice.	
Literature	Die Literatur wird kurzfristig festgelegt.	

Course L2379: Special topics	of civil engineering 2 LP
Тур	
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2380: Special topics of civil engineering 3 LP	
Тур	
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and	wird zu Beginn der Lehrveranstaltung festgelegt
scale	
Lecturer	Dozenten des SD B
Language	DE
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2789: Structural Design		
Тур	Seminar	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Mündliche Prüfung	
Examination duration and	20 min	
scale		
Lecturer	Dr. Jan Mittelstädt	
Language	DE/EN	
Cycle	SoSe	
Content		
Literature	[1] Structure Systems by Heino Engel, Hantje Cantz, 3rd edition (Feb 2007), ISBN-10: 3775718761	
	Form and Force, Designing Efficient, Expressive Structures by Allan, E., Zalewski, W. et al, John Wiley and	
	Sons; 1st edition (Sept 2009), ISBN-10: 047017465X	
	[2] Peter Rice: An Engineer Imagines, ISBN-10 : 1849944237	
	[3] Konrad Wachsmann and the Grapevine Structure by C. Sumi et al., Park Books (Oct 2018), ISBN-10:	
	9783038601104	
	[4] Manual of Multi-Story Timber Construction by Hermann Kaufmann, Stefan Krotsch, Stefan Winter, DETAIL,	
	(June 2018), ISBN-10: 3955533948	
	[5] The Art of Structural Design: A Swiss Legacy by B. Billington, Princeton University Art Museum; First Edition	
	edition (Mar 2003), ISBN-10: 0300097867	
	[6] Structured Lineages: Learning from Japanese Structural Design by G. Nordenson et al, The Museum of	
	Modern Art (Jul 2019), ISBN-10: 1633450562	
	[7] The Structure: Works of Mahendra Raj by V. Mehta, R. Mehndiretta, A. Huber, Park Books (Oct 2015),	
	ISBN-10: 3038600253	

rotection in a Changing Climate (SeaPiaC) (L2926)	<b>Typ</b> Project-/problem-based Learning	Hrs/wk	<b>CP</b> 6
Prof. Peter Fröhle			
None			
<ul> <li>Hydraulic Engineering</li> <li>Hydromechanics, Hydraulics</li> <li>Fundamentals of Coastal Engineering, Coastal- ar</li> </ul>	d Flood Protection		
After taking part successfully, students have reached th	e following learning results		
<ul> <li>Consequences of Climate Change for Coastal Proc</li> <li>Coastal Protection in Taiwan and Germany</li> <li>Fundamentals of Climate Adaptation</li> </ul>	tesses		
Creative thinking: development of adaptation stra	tegies and adaptation measures	nods, numeric	al models, plannir
<ul> <li>Working in heterogenous groups</li> <li>Working in international groups</li> <li>Working with different scientific / non-scientific di</li> <li>Self reflection</li> </ul>	sciplines		
<ul><li>Application oriented use of knowledge and skills</li><li>Autonomous work on complex tasks</li></ul>			
Independent Study Time 124, Study Time in Lecture 56			
None			
Written elaboration			
Preparation of a written report on a complex task with	a presentation and subsequent discussion	on. The work	on the complex ta
happens in the course of the lecture.			
Civil Engineering: Specialisation Geotechnical Engineerin Civil Engineering: Specialisation Structural Engineering: Civil Engineering: Specialisation Water and Traffic: Elect Environmental Engineering: Specialisation Environment	ng: Elective Compulsory Elective Compulsory ive Compulsory and Climate: Elective Compulsory		
	<ul> <li>Hydromechanics, Hydraulics</li> <li>Fundamentals of Coastal Engineering, Coastal- an</li> <li>After taking part successfully, students have reached the</li> <li>Climate and Climate Change</li> <li>General Impacts of Climate Change on Wind Regi</li> <li>Consequences of Climate Change for Coastal Processes and Protection in Taiwan and Germany</li> <li>Fundamentals of Climate Adaptation</li> <li>Nature-based Solutions (NBS) for Coastal Protection</li> <li>Critical thinking: analysis of processes and relation</li> <li>Creative thinking: development of adaptation strations</li> <li>Practical thinking: inclusion of restrictions, applimethods</li> <li>Consideration of complex tasks</li> <li>Working in heterogenous groups</li> <li>Working with different scientific / non-scientific di</li> <li>Self reflection</li> <li>Application oriented use of knowledge and skills</li> <li>Autonomous work on complex tasks</li> </ul> Independent Study Time 124, Study Time in Lecture 56 6 None Written elaboration Preparation of a written report on a complex task with happens in the course of the lecture. Civil Engineering: Specialisation Coastal Engineering: Election Civil Engineering: Specialisation Structural Engineering: Civil Engineering: Specialisation Coastal Engineering: Civil Engineering: Specialisation Cited to Specialisation Cited t	Prof. Peter Fröhle         None         • Hydraulic Engineering         • Hydromechanics, Hydraulics         • Fundamentals of Coastal Engineering, Coastal- and Flood Protection         After taking part successfully, students have reached the following learning results         • Climate and Climate Change         • General Impacts of Climate Change on Wind Regime and Water Cycle         • Consequences of Climate Change for Coastal Processes         • Coastal Protection in Taiwan and Germany         • Fundamentals of Climate Adaptation         • Nature-based Solutions (NBS) for Coastal Protection         • Critical thinking: analysis of processes and relations, assessment of needs for action         • Critical thinking: analysis of processes and relations of calculation approaches, methethods         • Consideration of complex tasks         • Working in International groups         • Working in International groups         • Working with different scientific / non-scientific disciplines         • Self reflection         • Application oriented use of knowledge and skills         • Autonomous work on complex tasks         Independent Study Time 124, Study Time in Lecture 56         6         None         Written elaboration	Prof. Peter Fröhle None  Hydraulic Engineering Hydromechanics, Hydraulics Fundamentals of Coastal Engineering, Coastal- and Flood Protection After taking part successfully, students have reached the following learning results  Climate and Climate Change General Impacts of Climate Change on Wind Regime and Water Cycle Coastal Protection in Taiwan and Germany Locastal Protection in Taiwan and Germany Fundamentals of Climate Adaptation Nature-based Solutions (NBS) for Coastal Protestes Coastal Protection in Taiwan and Germany Fundamentals of Climate Adaptation Nature-based Solutions (NBS) for Coastal Protection Critical thinking: analysis of processes and relations, assessment of needs for action Creative thinking: development of adaptation strategies and adaptation measures Practical thinking: inclusion of restrictions, application of calculation approaches, methods, numeric methods Consideration of complex tasks Working in heterogenous groups Working in international groups Working with different scientific / non-scientific disciplines Self reflection Application oriented use of knowledge and skills Autonomous work on complex tasks Independent Study Time 124, Study Time in Lecture 56 6 None Written elaboration Preparation of a written report on a complex task with a presentation and subsequent discussion. The work of happens in the course of the lecture. Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Structur

Course L2926: Sustainable N	ature-based Coastal Protection in a Changing Climate (SeaPiaC)
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Peter Fröhle
Language	EN
Cycle	WiSe
Content	<ul> <li>Climate and Climate Change</li> <li>General Impacts of Climate Change on Wind Regime and Water Cycle</li> <li>Consequences of Climate Change for Coastal Processes</li> <li>Coastal Protection in Taiwan and Germany</li> <li>Fundamentals of Climate Adaptation</li> <li>Nature-Based Solutions (NBS) for Coastal Protection</li> </ul>
Literature	<ul> <li>Materials provided on eLearning Platform (HOOU Platform)</li> <li>Depending on the main topics of the course in the respective year, the literature ( recent papers) will be provided in the course-material or via StudIP.</li> </ul>

Courses				
Title		Тур	Hrs/wk	СР
Construction law BGB and VOB - la	w in (excavation) practice (L3182) uction (excavation) practice (L3181)	Lecture Lecture	2	3 3
Module Responsible		Lecture	Z	5
Admission Requirements				
	Complete modules: Geotechnics I-III			
Knowledge				
5	After taking part successfully, students have rea	ched the following learning results		
Professional Competence		5 5		
	Students will gain knowledge of			
	• the history of civil engineering law,			
	basics of foundation and civil engineering	law,		
	legal aspects of technical regulations in ci	vil engineering (with case studies),		
	<ul> <li>the civil engineering contract,</li> </ul>			
	the liability of the designer and contractor	in civil engineering,		
	<ul> <li>the subsoil risk and the system risk,</li> </ul>			
	<ul> <li>the total debt in (civil) engineering law,</li> <li>the (construction) conflict, dicpute avoidable</li> </ul>	aco models and the construction proce		
	<ul> <li>the (construction) conflict, dispute avoidant</li> <li>the systematics of construction contract la</li> </ul>		255,	
	<ul> <li>the BGB construction contract law,</li> </ul>	, , , , , , , , , , , , , , , , , , ,		
	<ul> <li>responsibilities on the construction site,</li> </ul>			
	<ul> <li>remuneration and contract management,</li> </ul>			
	<ul> <li>liability for defects,</li> </ul>			
	public procurement law			
	Disturbed construction processes: How me	uch money am I entitled to?		
	Correct calculation of supplements.			
Skills	Students learn to apply legal aspects in planning	g and construction in a legally balance	ed way. Students learn h	now to use legal a
	construction management aspects in practice (p	planning and construction) on the construction	struction site in a target	ted manner and h
	to manage the construction project optimally.			
Personal Competence				
Social Competence	Students can work in groups and support each of	ther in finding solutions.		
Autonomy	Students are able to assess their own strengths a	and weaknesses and organize their tin	ne and learning manage	ment based on thi
Workload in Hours	Independent Study Time 124, Study Time in Lect	ture 56		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Enginee	ring: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical En	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Engin			
	Civil Engineering: Specialisation Water and Traffi			
	Civil Engineering: Specialisation Computational E	ngineering: Elective Compulsory		

Course L3182: Construction	urse L3182: Construction law BGB and VOB - law in (excavation) practice	
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Günther Schalk	
Language	DE	
Cycle	WiSe	
Content		
Literature	Literatur:	
	- Folienskript (in der Vorlesung erhältlich)	
	- Fuchs/Maurer/Schalk: Handbuch Tiefbaurecht	

Course L3181: Construction	ourse L3181: Construction disputes from construction (excavation) practice	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Ingo Junker	
Language	DE	
Cycle	WiSe	
Content		
Literature		

Courses				
Courses				
<b>Title</b> Waste and Environmental Chemisti	N (1 0229)	<b>Typ</b> Practical Course	Hrs/wk 2	<b>CP</b> 2
Biological Waste Treatment (L0318	-	Project-/problem-based Learning	2	4
Module Responsible			-	-
Admission Requirements				
	chemical and biological basics			
Keconniended Previous				
5	After taking part successfully, students have re	ached the following learning results		
Professional Competence	Arter taking part successivily, students have re			
	The module sime possess knowledge concernin	g the planning of biological waste treatment plan	te Studente a	re able to explair
Knowledge		ste treatment plants in detail, describe different t		
	plants for biological waste treatment plants and		cerniques for	waste gas treath
	planes for biological waste dicatment planes and	explain american methods for waste analytics.		
Skills	The students are able to discuss the compilation	n of design and layout of plants. They can critical	llv evaluate ter	chniques and qui
SKIIS		erché and evaluate literature and date connected		
	and plan additional tests. They are capable of r			<u>.</u>
Personal Competence				
•	Students can participate in subject-specific an	d interdisciplinary discussions, develop cooperat	ed solutions a	nd defend their
		he scientific development in front of colleagues		
	accept professional constructive criticism.			, , , . , , . , ,
Autonomy	Students can independently tap knowledge fro	m literature, business or test reports and transfo	orm it to the c	ourse projects. T
	are capable, in consultation with supervisors as	well as in the interim presentation, to assess the	eir learning lev	el and define fur
	steps on this basis. Furthermore, they can def	ine targets for new application-or research-orien	ted duties in a	accordance with
	potential social, economic and cultural impact.			
Workload in Hours	Independent Study Time 110, Study Time in Le	cture 70		
Credit points				
Course achievement	Compulsory Bonus Form	Description		
	Yes None Subject theoretical practical work	and		
Evenination	P			
Examination		around		
Examination duration and scale	Elaboration and Presentation (15-25 minutes in	groups)		
Assignment for the	Civil Engineering: Specialisation Coastal Engine	oring: Elective Compulson		
Following Curricula	Civil Engineering: Specialisation Coastal Engine Civil Engineering: Specialisation Geotechnical E	5 1 5		
ronowing curricula	Civil Engineering: Specialisation Structural Engi			
	Civil Engineering: Specialisation Structural Engi Civil Engineering: Specialisation Water and Traf	5 1 5		
		eral Bioprocess Engineering: Elective Compulsory		
		sation General Process Engineering: Elective Com	pulsory	
		sation Bioprocess Engineering: Elective Compulso		
		sation Chemical Process Engineering: Elective Cor	-	
	Environmental Engineering: Core Qualification:			
	International Management and Engineering: Sp	ecialisation II. Renewable Energy: Elective Compu	ulsory	
	Process Engineering: Specialisation Environmer	ntal Process Engineering: Elective Compulsory		
	Water and Environmental Engineering: Speciali	sation Cities: Elective Compulsory		

Course L0328: Waste and En	vironmental Chemistry
Тур	Practical Course
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	The participants are divided into groups. Each group prepares a transcript on the experiment performed, which is then used as basis for discussing the results and to evaluate the performance of the group and the individual student. In some experiments the test procedure and the results are presented in seminar form, accompanied by discussion and results evaluation. Experiments ar e.g. Screening and particle size determination Fos/Tac AAS Chalorific value
Literature	Scripte

Course L0318: Biological Wa	ourse L0318: Biological Waste Treatment	
Тур	Project-/problem-based Learning	
Hrs/wk	3	
СР	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Kerstin Kuchta	
Language	EN	
Cycle	WiSe	
Content	<ol> <li>Introduction</li> <li>biological basics</li> <li>determination process specific material characterization</li> <li>aerobic degradation ( Composting, stabilization)</li> <li>anaerobic degradation (Biogas production, fermentation)</li> <li>Technical layout and process design</li> <li>Flue gas treatment</li> <li>Plant design practical phase</li> </ol>	
Literature		

Hrs/wk	СР
3	3
2	2
1	1
mechanical,	chemical and therm
	f waste technologie
operations .	i waste technologie
operations .	
with respect (	to their characteristi
	e treatment concepts
	They are capable,
	more, they can defi
economic and	cultural impact.
Written exam	
/	
npulsory	
ory	
ompulsory	
oulsory	

Course L3267: Planning of w	aste treatment plants
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Rüdiger Siechau
Language	EN
Cycle	WiSe
Content	The focus is on getting to know the organization and practice of waste management companies. Topics such as planning, financing and logistics will be discussed and there will be an excursion (waste incineration plant, vehicle fleet and collection systems / containers). Project based learning: You will be given a task to work on independently in groups of 4 to 6 students. All tools and data needed for the project work will be discussed in the lecture "Recycling Technologies and Thermal Waste Treatment". Course documents can be downloaded from StudIP. Communication during the project work also takes place via StudIP.
Literature	<ul> <li>Einführung in die Abfallwirtschaft; Martin Kranert, Klaus Cord-Landwehr (Hrsg.); Vieweg + Teubner Verlag; 2010</li> <li>PowerPoint Präsentationen in Stud IP</li> </ul>

Course L3265: Recycling tec	hnologies and thermal waste treatment
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	<ul> <li>Introduction, actual state-of-the-art of waste incineration, aims. legal background, reaction principals</li> <li>basics of incineration processes: waste composition, calorific value, calculation of air demand and flue gas composition</li> <li>Incineration techniques: grate firing, ash transfer, boiler</li> <li>Flue gas cleaning: Volume, composition, legal frame work and emission limits, dry treatment, scrubber, de-nox techniques, dioxin elimination, Mercury elimination</li> <li>Ash treatment: Mass, quality, treatment concepts, recycling, disposal</li> </ul>
Literature	Thomé-Kozmiensky, K. J. (Hrsg.): Thermische Abfallbehandlung Bande 1-7. EF-Verlag für Energie- und Umwelttechnik, Berlin, 196 - 2013.

Course L3266: Recycling technologies and thermal waste treatment	
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M2033: Subsu	Irface Processes			
Courses				
Title		Тур	Hrs/wk	СР
Modeling of Subsurface Processes (	L2731)	Recitation Section (small)	3	3
Subsurface Solute Transport (L272)	3)	Lecture	2	2
Subsurface Solute Transport (L272	9)	Recitation Section (large)	1	1
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic Mathematics, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students hav	ve reached the following learning results		
Professional Competence				
Knowledge	Upon completion of this module, the students will understand the mechanisms controlling solute transport in soil and natural porous media and will be able to work with the equations that govern the fate and transport of solutes in porous media. Analytical, numerical and experimental tools and techniques will be used in this module.			
Skills	In addition to the physical insights, the students will be exposed to analytical, experimental and numerical tools and techniques in this module. This provides them with an excellent opportunity to improve their skills on multiple fronts which will be useful in their future career.			
Personal Competence				
Social Competence	Teamwork & problem solving			
Autonomy	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability ar			
	willingness to work independently and resp	oonsibly.		
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84		
Credit points				
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Report			
scale				
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory		
•	Civil Engineering: Specialisation Geotechni			
-	Civil Engineering: Specialisation Coastal En	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and			
	Civil Engineering: Specialisation Computati	ional Engineering: Elective Compulsory		
	Environmental Engineering: Core Qualificat	tion: Compulsory		
	Process Engineering: Specialisation Enviror	nmental Process Engineering: Elective Compulsory	¢.	
	Process Engineering: Specialisation Process	s Engineering: Elective Compulsory		
	Water and Environmental Engineering: Spe	ecialisation Water: Compulsory		
	Water and Environmental Engineering: Spe			

Course L2731: Modeling of S	ubsurface Processes
Тур	Recitation Section (small)
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Milad Aminzadeh
Language	EN
Cycle	WiSe
Content	Basic usage and background of chosen computer software to calculate flow and transport in the saturated and unsaturated zone
	and to analyze field data like pumping test data
Literature	

Course L2728: Subsurface So	olute Transport
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	Basic physical properties of soil: Definition and quantification; Liquid flow in soils (Darcy's law); Solute transport in soils; Practical analysis to measure dispersion coefficient in soil under different boundary conditions; Advanced topics (e.g. Application of Artificial Intelligence to predict soil salinization)
Literature	- Environmental Soil Physics, by Daniel Hillel - Soil Physics, Sixth Edition, by William A. Jury and Robert Horton

Course L2729: Subsurface Solute Transport		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Hannes Nevermann	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

	Thesis		
Module M1801: Maste	er thesis (dual study program)		
Courses			
Title	Typ Hrs/wk CP		
Module Responsible	Professoren der TUHH		
Admission Requirements	None		
Recommended Previous Knowledge			
-	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	Dual students		
	<ul> <li> use the specialised knowledge (facts, theories and methods) from their field of study and the acquired profession, knowledge confidently to deal with technical and practical professional issues.</li> <li> can explain the relevant approaches and terminologies in depth in one or more of their subject's specialist area describe current developments and take a critical stance.</li> <li> formulate their own research assignment to tackle a professional problem and contextualise it within their subject area. They ascertain the current state of research and critically assess it.</li> </ul>		
Skills	Dual students		
	<ul> <li> can select suitable methods for the respective subject-related professional problem, apply them and develop them further as required.</li> <li> assess knowledge and methods acquired during their studies (including practical phases) and apply their expertise to complex and/or incompletely defined problems in a solution- and application-oriented manner.</li> <li> acquire new academic knowledge in their subject area and critically evaluate it.</li> </ul>		
Personal Competence			
Social Competence	Dual students		
	<ul> <li> can present a professional problem in the form of an academic question in a structured, comprehensible and factual correct manner, both in writing and orally, for a specialist audience and for professional stakeholders.</li> <li> answer questions as part of a professional discussion in an expert, appropriate manner. They represent their own point of view and assessments convincingly.</li> </ul>		
	<ul> <li>Dual students</li> <li> can structure their own project into work packages, work through them at an academic level and reflect on them with regard to feasible courses of action for professional practice.</li> <li> work in-depth in a partially unknown area within the discipline and acquire the information required to do so.</li> <li> apply the techniques of academic work comprehensively in their own research work when dealing with an operational problem and question.</li> </ul>		
Workload in Hours	Independent Study Time 900, Study Time in Lecture 0		
Credit points	30		
Course achievement	None		
Examination			
Examination duration and scale	According to General Regulations		
	Civil Engineering: Thesis: Compulsory		
Following Curricula	Bioprocess Engineering: Thesis: Compulsory		
	Chemical and Bioprocess Engineering: Thesis: Compulsory		
	Computer Science: Thesis: Compulsory Data Science: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory		
	Energy Systems: Thesis: Compulsory		
	Environmental Engineering: Thesis: Compulsory Aircraft Systems Engineering: Thesis: Compulsory		
	Computer Science in Engineering: Thesis: Compulsory		
	Information and Communication Systems: Thesis: Compulsory		
	International Management and Engineering: Thesis: Compulsory		
	Logistics, Infrastructure and Mobility: Thesis: Compulsory Aeronautics: Thesis: Compulsory		
	Materials Science and Engineering: Thesis: Compulsory		
	Materials Science: Thesis: Compulsory		
	Mechanical Engineering and Management: Thesis: Compulsory		
	Mechatronics: Thesis: Compulsory Biomedical Engineering: Thesis: Compulsory		
	Microelectronics and Microsystems: Thesis: Compulsory		
	1		

## Module Manual M.Sc. "Civil Engineering"

Product Development, Materials and Production: Thesis: Compulsory
Renewable Energies: Thesis: Compulsory
Naval Architecture and Ocean Engineering: Thesis: Compulsory
Theoretical Mechanical Engineering: Thesis: Compulsory
Process Engineering: Thesis: Compulsory
Water and Environmental Engineering: Thesis: Compulsory