

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Semestre 1

	CM (UE)	TD (UE)	ECTS
Concrete Structures			5
Concrete Structures	45		5
Steel & Composite Structures 1 – High Rise Buildings			5
Steel & Composite Structures 1 – High Rise Buildings	45		5
Methods in Digital Building - BIM			4
Methods in Digital Building - BIM	45		4
Thin Walled Structures			5
Thin Walled Structures	45		5
Finite Element Analysis of Structures (incl. Matlab)			5
Finite Element Analysis of Structures (incl. Matlab)	36		5
Circular Economy			3
Circular Economy	30		3
Life Cycle Assessment and Eco Design			3
Life Cycle Assessment and Eco Design	45		3

Semestre 2

	CM (UE)	TD (UE)	ECTS
Energy efficiency of buildings, part 1 & lab 1			10
Energy efficiency of buildings, part 1 & lab 1	30		4
Energy efficiency of buildings, part 1 & lab 1			10
Energy efficiency of buildings, part 1 and 2 & lab 1	60	15	4

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

	CM (UE)	TD (UE)	ECTS
Structural Dynamics			4
Structural Dynamics	40		4
Transport Systems Analysis			4
Transport Systems Analysis	45		4
Transport Systems - Project			2
Transport Systems - Project	30		2
Engineering Surveying			5
Engineering Surveying	24	120	5
Sustainable Water and Resources Management			5
Sustainable Water and Resources Management	45		5
Managerial Accounting			3
Managerial Accounting	36		3
Underground structures Advanced soil mechanics			3
Underground structures Advanced Soil Mechanics	30		3

Semestre 3

	CM (UE)	TD (UE)	ECTS
Advanced (Design) project / Case Study			9
Advanced (Design) project / Case Study	30		9
Prestressed Concrete Structures			5
Prestressed Concrete Structures	45		5
Steel & Composite Structures 2 – Bridges			4
Steel & Composite Structures 2 – Bridges	45		4



Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

	CM (UE)	TD (UE)	ECTS
Numerical soil mechanics			4
Numerical soil mechanics	45		4
Composite Structures & Fire Design			5
Composite Structures & Fire Design	45		5
Scientific writing and presentation skills			3
Scientific writing and presentation skills	58		3

Semestre 4

	CM (UE)	TD (UE)	ECTS
Master thesis			30
Master thesis	30		30

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Semestre 1

Concrete Structures

Module:	Concrete Structures (Semestre 1)
ECTS:	5
Objectif:	<p>The student will learn about the frame system, the structural element types and time-dependent behavior of tall buildings.</p> <p>Furthermore he is aware of seismic aspects of tall buildings.</p> <p>He knows how to design a whole multi-story building of reinforced concrete with its different structural elements.</p>
Course learning outcomes:	At the end of this course the students will be able to understand principles of tall building design, to design a complete building of reinforced concrete and to consider design aspects for seismic solicitations.
Description:	<ul style="list-style-type: none">• Tall Buildings:<ul style="list-style-type: none">- Analysis of core systems, structural framings systems, types of structural elements for floors, columns, walls and foundations, workability, loading and time-dependent behavior of tall buildings.• Seismic design of buildings according to Eurocode 8:<ul style="list-style-type: none">- Overview of Eurocode 8- Modeling and analysis of a design example with description of building and actions- Discussion of structural regularity- Structural type of building and behavior factor- Model response spectrum analysis- Lateral force analysis• Design of a multistory reinforced concrete building<ul style="list-style-type: none">- Description of project- Determination of framing system- Design of flat slab (bending, shear/punching)- Design of one-way spanned slab- Design of inner/edge column
Modalité d'enseignement:	Lecture
Langue:	Anglais
Obligatoire:	Oui
Evaluation:	Semester project and written or oral examination, 90 min
Remarque:	[1] EC2: Design of concrete structures

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

[2] EC8: Design of structures for earthquake resistance

[3] fib Bulletin No. 73: Tall buildings, Structural design of concrete buildings up to 300m tall. State-of-the-art report, 2014. ISBN: 978-2-88394-113-7.

Professeur: WALDMANN Daniele

Steel & Composite Structures 1 – High Rise Buildings

Module: Steel & Composite Structures 1 – High Rise Buildings (Semestre 1)

ECTS: 5

Objectif: Civil Structural Engineering

The learning targets concern different types of steel and steel composite structures of multi-storey- and tall buildings. Light flooring construction types and special bracing constructions for high-rise buildings in steel and steel composite structure are determined and analysed.

Special calculation methods, like the determination of the Eigenfrequency of a building and important constructional rules, for example the combination of different bracing elements are known.

Different Methods of optimizing the building construction elements - with the different target parameters like construction time, simplicity of assembly, degree of prefabrication and reduction of steel tonnage is known. Especially the last point is important, which insists in the basis for the later judgement of CO₂-equivalent concerning the sustainable construction with limited resources.

The student is able to work interdisciplinary in a team of structural engineers and architects.

Learning the mutual understanding is important in a sense, that different actors in the building sector have – according to their profession and assignment – different "languages" and also different targets to achieve.

Architectural Engineering

The student in Architectures is able to work in an interdisciplinary group of Architects and Structural Engineers.

He knows about the different challenges of high-rise buildings in comparison with residential buildings and multi-storey buildings.

He can draft a high-rise building with consideration of the most important structural elements in combination with a structural engineer. He knows the different structural elements, which are necessary for the vertical load take down and the building's bracing.

Course learning outcomes: Civil Structural Engineering

1. The student is able to work in an interdisciplinary team of Architects and Structural Engineers.

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

2. The student is able to propose different ways of constructing and analysing composite slab systems for high-rise buildings in steel and concrete and knows how to prove its load bearing capacity. The student can propose the different methods to brace high-rise buildings and is able to calculate the stability of the bracing system.

3. The student is able to draft different structural systems for wide span constructions, to name assessment criteria and to judge the respective advantages and disadvantages.

4. The student is able to draft and design a standard bridge with the special required proofs of fatigue for the steel details.

Architecture

1. The student is able to work in an interdisciplinary team of Architects and Structural Engineers.

2. The student is able to develop a rough draft of a high rise building with the knowledge about the necessity of structural systems

Description:

High Rise Buildings in Steel and Concrete Composite Structure

- Introduction
- Exemplification of worldwide well known buildings
- Slab structures in composite steel and concrete structures
- Impacts on high rise systems
- Bracing systems
- Structural analysis
- Circular Economy and Reusable Systems
- Judgement criteria concerning construction time, simplicity of assembly, degree of prefabrication and reduction of resources namely steel tonnage and concrete volume

1. This course is focusing on the first theme: the design of large structures in steel and composites.

2. The subject Sustainability is tackled in the chapter about reusable systems for a circular economy.

Modalité d'enseignement:

Lecture and Workshops

Langue:

Anglais

Obligatoire:

Oui

Evaluation:

Development of a High Rise Building –

1. Participation in the lectures and workshops

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

2. Development and Draft of a HR building within an interdisciplinary team
3. Quality and plausibility of the developed solution
4. Final report with structural analysis, architectural drawings and structural drawings
5. Final presentation

Remarque: Script
C. Petersen; "Stahlbau", Vieweg-Verlag
K.-J. Schneider; "Bautabellen für Ingenieure"; Werner Verlag
"Betonkalender", Verlag Ernst und Sohn
"Stahlbau-Kalender", Verlag Ernst und Sohn
S. Bungale; S.E. Taranath; "Wind and Earthquake Resistant Buildings",
W.F. Chen, E.M. Lui; "Handbook of Structural Analysis and Design"; Taylor and Francis, Boca Raton, USA

Professeur: ODENBREIT Christoph, KOZMA Andras

Methods in Digital Building - BIM

Module: Methods in Digital Building - BIM (Semestre 1)

ECTS: 4

Objectif:

- "Methods in Digital Building – BIM" will start by showing how a BIM construction project works from several points of view with many examples and practical BIM use cases. It will also with a comparative overview of many BIM tools.
- Then, the student will face a "real life" situation of a structural Engineer and will have several tools at disposal to manage all his tasks for the project.
- The bridge between this course and the Concrete structural course will be one more example that illustrates how a BIM workflow helps to reuse what have been done in a previous step.

Course learning outcomes: On completion of the course unit successful students will be able to:

- understand what a BIM process is through every project phase, from programming to maintenance.
- Manage a BIM Structural project as a Civil Engineering with several tools: drawing tool, exchange information through a BIM collaboration Platform with other stakeholders, generate quantity take off from a 3D model and generate Documentation (2D and 3D drawings), generate a 3D model for structural analysis

Description:

- BIM – Lecture with application along a project's live cycle, live demo and exercises for students
- Introduction to Autodesk Revit: Basis + structural tools
- Introduction to Dalux Field: collaborative online BIM platform, which will be used to exchange every comments and files during this class
- Workshop on Revit to create a Structural project within a BIM process
- Workshop on Revit to extract quantities, add reinforcement in concrete and generate drawing
- Workshop on BIMoffice to generate Estimation forms from the 3D models

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

- Workshop on Revit and/or Navisworks for clash detection between 3D models (Architectural, Structural and MEP).

Langue:	Anglais
Obligatoire:	Oui
Evaluation:	One project work with several steps to submit on a web platform by the 10 thof January: quote 100%
	Presence requirement: 80% of the time (cases of force majeure are not considered, but must be submitted to the Lecturer)
Remarque:	Literature: Autodesk Revit Documentation and Online Help for Revit – BIMoffice – Dalux Field Autodesk Revit Fundamentals for Structure / Ascent
Professeur:	BOON-BELLINASO Charlie

Thin Walled Structures

Module:	Thin Walled Structures (Semestre 1)
ECTS:	5
Objectif:	The students know about the load-bearing behavior of thin-walled structures. They are familiar with the fundamental mathematical modeling of planes and shells with emphasis on boundary conditions (restraints and loading) and stress/strain concentrations. The students know the basics of available solution methods, especially finite element methods for thin-walled structures.
Course learning outcomes:	On completion of the course unit successful students will be able to: The students will be able to select the appropriate structural model for plane and curved thin-walled structures. They can perform the structural analysis of plane and curved thin-walled structures and are able to perform a critical interpretation of the resulting stress distribution and displacements.
Description:	The students know about the load-bearing behavior of thin-walled structures. They are familiar with the fundamental mathematical modeling of planes and shells with emphasis on boundary conditions (restraints and loading) and stress/strain concentrations. The students know the basics of available solution methods, especially finite element methods for thin-walled structures.

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Theory of plane thin-walled structures:

- fundamental equations and membrane/bending load-bearing behaviour of plates, influence of boundary conditions, trajectory of principal stresses and dimensioning, plane strain/plane stress conditions, generalisation to spatial and rotational-symmetric load-bearing structure.

- fundamental equations and load-bearing behaviour of thin (Kirchhoff) and medium-thick (Reissner) plates, principal moments and dimensioning, theory-dependent influence of boundary conditions. Orthotropic plates, folded plates, circular plates.

Theory of curved thin-walled structures:

- fundamental equations and load-bearing behaviour of shells of revolution, membrane theory and bending theory, extension to non-rotational-symmetric conditions.

Based on the theory, the lecture complementary discusses methods of finding closed and approximate solutions to the governing equations in displacement and displacement/stress form: solution of partial differential equations, application of the principle of virtual displacements and virtual stresses to thin-walled structures, ansatz functions of full-field support and local support (finite elements). Discussion of quality and sensitivity of the solution.

Modalité d'enseignement:	Lectures
Langue:	Anglais
Obligatoire:	Oui
Evaluation:	Semester project with report & presentation
Remarque:	<ul style="list-style-type: none">• Lecture slides, notes on blackboard, computer framework using MATLAB;• Timoshenko, Woinowsky-Krieger: Theory of plates and shells (McGraw-Hill)• Jawad: Theory and design of plate and shell structures (Chapman and Hall), ????• Reddy: Theory and analysis of elastic plates and shells (Taylor & Francis), ????• Ugural: Stresses in beams, plates and shells (CRC Press),• Marti: Theory of structures (Wiley)• Blaauwendraad, Hoefakker, Gladwell: Structural shell analysis (Springer)
Professeur:	ZILIAN Andreas, HOAREAU Christophe, DEHGhani Hamidreza

Finite Element Analysis of Structures (incl. Matlab)

Module:	Finite Element Analysis of Structures (incl. Matlab) (Semestre 1)
ECTS:	5

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Course learning outcomes:

On completion of the course unit successful students will be able to:

Starting from basic strong-form governing equations of linear but also geometrically/physically nonlinear structural problems, the students will be able to obtain the associated (linearised) weak form on the basis of the principle of virtual displacements and virtual forces. They know about the most important steps of discretization of geometry and physics, they are familiar with the basic (isoparametric) Lagrange-type elements in 1D, 2D and 3D. The students can identify and understand the steps of pre-processing, element matrix computation, system matrix assembly, solution and post-processing in theory and source code (MATLAB). The students will be able to distinguish stress and stability problems and to perform reliable assessment of finite element analyses to linear and nonlinear structures.

Description:

The students are familiarized with the concept of the finite element method as a means of obtaining an approximate solution to the mathematical model equations (partial differential equations) associated with standard structural components such as trusses, beams, slabs and plates. The focus of the course is on identifying (physics and mathematics) and processing (computer program implementation) the basic steps involved in a typical finite element analysis workflow from an academic point of view.

Matlab Intro contents:

M1. Introduction to MATLAB: Installation of Matlab Toolbox, Matlab concepts

M2. First steps with MATLAB: Walkthrough tutorial

Lecture Contents:

1. Introduction to FE as part of the design tool chain to structures, structural components
2. Overview on governing equations for some structures (spring, bar, beam, rope, slab, plate, membrane, shell, solid)
3. Method of weighted residuals (trial function, residual, test function, integral form, weak form)
4. Discretisation of geometry (partitioning of the domain, meshing, local coordinate system, mapping, Jacobi matrix)
5. Discretisation of physics (local and global derivatives, isoparametric concept)
6. Numerical integration of the weak form (Gauss quadrature): element matrix and element force vector, assembly, system of linear algebraic equations, solution methods (direct, iterative)
7. Nonlinear problems: general approach via Newton-Raphson method, consistent linearization
8. Physically nonlinear structures (material nonlinearities) -- nonlinear elasticity, elasto-plasticity
9. Geometrically nonlinear structures -- nonlinear truss, rope, beam, plate, ...
10. Stability analysis of structures: formulation as eigenvalue problem, buckling load and buckling shapes

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

- Langue:** Anglais
- Obligatoire:** Oui
- Evaluation:** Written exam + Exercices (50 % / 50 %)
- Remarque:**
- Lecture slides, notes on blackboard, academic FE framework based on MATLAB;
 - Complementary material (further reading):
 - Bathe, K.-J., Finite element procedure, Prentice Hall,1996
 - Belytschko, T.; Liu, W. K.; Moran, B. & Elkhodary, K. I., Nonlinear finite elements for continua and structures, John Wiley & Sons,2014
 - Bonet, J. & Wood, R. D., Nonlinear continuum mechanics for finite element analysis, Cambridge University Press,1997
 - de Borst, R.; Crisfield, M. A.; Remmers, J. J. C. & Verhoosel, C. V., Non-linear finite element analysis of solids and structures, John Wiley & Sons,2012
 - Braess, D., Finite elements: Theory, fast solvers, and applications in solid mechanics, Cambridge University Press,2001
 - Buchanan, G. R., Finite element analysis, McGraw-Hill,1995
 - Cook, R. D., Finite element modeling for stress analysis, John Wiley & Sons,1995
 - Ferreira, A. J. M., Matlab codes for finite element analysis: Solids and structures, Springer Science+Business Media,2009
 - Hartmann, F. & Katz, C., Structural analysis with finite elements, Springer,2007
 - Hughes, T. J. R., The finite element method: Linear static and dynamic finite element analysis, Dover Publications,1987
 - Logan, D. L., A first course in the finite element method, Cengage Learning,2010
 - Öchsner, A. , One dimensional finite elements: An introduction to FE Method, Springer-Verlag,2013
 - Oñate, E. , Structural analysis with the finite element method: Linear statics 1 - Basis and solids, Springer,2009
 - Oñate, E., Structural analysis with the finite element method: Linear statics 2 - Beams, plates and shells, Springer,2013
 - Reddy, J. N., An introduction to the finite element method, McGraw-Hill,2006
 - Reddy, J. N., An introduction to nonlinear finite element analysis, Oxford University Press,2004
 - Wriggers, P., Nonlinear finite element methods, Springer,2008

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

- Zienkiewicz, O. C.; Taylor, R. L. & Zhu, J. Z., The finite element method: Its basis and fundamentals, Butterworth-Heinemann, 2013
- Zienkiewicz, O. C.; Taylor, R. L. & Fox, D. D., The finite element method for solid and structural mechanics, Butterworth-Heinemann, 2014

Professeur: ZILIAN Andreas, HOAREAU Christophe, DEHGHANI Hamidreza

Circular Economy

Module: Circular Economy (Semestre 1)

ECTS: 3

Objectif: In this course, students will learn about the concept of circular economy, particularly in the construction sector, at the building and district level.

Course learning outcomes: Know the principles of the circular economy in general and in the construction sector.
Know the latest innovations in circularity
Know how to implement the principles of circular economy in a project.

Description: Students will be confronted with the reality on the ground. Students will discover new innovations, different certifications (C2C), new financial models, as well as the evolution of the circular economy. They will carry out group works on the application of the circular economy in a construction project.

Themes:

Circular economy, Sustainable construction, Eco-neighbourhood, Flexibility, Reuse/Repair/Recycling, Performance-as-a-Service.

Modalité d'enseignement: Lecture

Langue: Anglais

Obligatoire: Oui

Evaluation: Written exam and project work

Professeur: MAJERUS Samuel Joseph Christian

Life Cycle Assessment and Eco Design

Module: Life Cycle Assessment and Eco Design (Semestre 1)

ECTS: 3

Objectif: Students of this course learn to design products/megastructures following the principles of sustainability. For that, students get to know what sustainable products and sustainable resources can mean. Additionally, students understand how a product's performance for sustainability can be assessed in order to critically reflect on it. Particularly, the course aims at enabling students to apply life cycle assessment (LCA) and eco-design methods.

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Course learning outcomes:

After successfully participating in the course, students will be able to

- 1.) independently improve the environmental performance of their products/megastructures and developing sustainable product concepts by applying eco-design strategies, principles and methods in the early stages of the development process,
- 2.) integrate the ecological perspective in the technical product creation,
- 3.) critically analyze LCA studies, and
- 4.) conduct their own LCA studies.

Description:

The course includes a mix of lecture, individual and group work exercises, discussions and feedback sessions. Students work on one assignment and present it in the course. In addition to the final examination, this assignment contributes to the rating of students.

The content of the course focusses on the following main areas:

- Introduction to sustainable development and related concepts such as circular economy and planetary boundaries.
- The importance of life cycle thinking/management for engineers from a business perspective in the context of sustainable development
- The life cycle of products and megastructures
- Environmental impacts of products and megastructures and their indicators
- Examples of eco-designed products
- Eco-design strategies, principles and methods
- Limitations of eco-design
- The importance of LCA
- (Manual) calculation of LCA
- Software tools
- Practical issues of LCA
- Critical review of LCA studies (assignment)
- Extensions of LCA through planetary boundaries and Life Cycle Benefit Analysis
- LCA and eco-design in early stages of the development process

Modalité d'enseignement:

Lecture

Langue:

Anglais

Obligatoire:

Oui

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Evaluation: Written Examination

Remarque: Baumann, H; Tillman, A-M: The Hitch Hiker's Guide to LCA: An Orientation in Life Cycle Assessment Methodology and Applications. Professional Pub. Service 2004

Vogtländer, J: LCA-based assessment of sustainability: the Eco-costs/Value Ratio EVR. Delft Academic Press DAP 2010

Jonker, G; Harmsen, J: Engineering for Sustainability: A Practical Guide for Sustainable Design. Elsevier 2012

Crul, M.R.M; Diehl J.C: Design for Sustainability: A Step-by-Step Approach. United Nations Environment Programme 2009

Vezzoli, C; Manzini E: Design for Environmental Sustainability. Springer 2008

Professeur: WALTERSDORFER Gregor

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Semestre 2

Energy efficiency of buildings, part 1 & lab 1

Module:	Energy efficiency of buildings, part 1 & lab 1 (Semestre 2)
ECTS:	4
Langue:	Anglais
Obligatoire:	Oui
Professeur:	MAAS Stefan

Energy efficiency of buildings, part 1 and 2 & lab 1

Module:	Energy efficiency of buildings, part 1 & lab 1 (Semestre 2)
ECTS:	4
Objectif:	comprehensive understanding of Energy Performance Certificates (EPC) for buildings, mandatory within EU
Course learning outcomes:	students understand basics of comfort and energy in buildings
Description:	<p>Part I: Basics in building physics and energy efficiency of buildings (Prof. Maas, 2h / 2.5 ECTS) Role of the building Actual situation of administrative buildings Contaminants in buildings Comfort and needs of occupants How to assure thermal comfort Windows (gains, losses, orientation) Air tightness Thermal inertia Ventilation, cooling Heat pumps and solar collectors Heat recovery heating needs, final energy and primary energy coefficients of performance energy performance certificates the norm EN832 the Energy Performance of Buildings Directives (EPBD): 2002/91/EC & 2010/31/EU Literature: 1. Detailed syllabus 2. Roulet, Santé et qualité de l'environnement intérieur dans les bâtiments, 2004, Lausanne Part II: Technical installations (Prof Scholzen, 2h / 2.5 ECTS) - Introduction: active and passive measures - Heating: Heat load, heating systems, heat Production and distribution - Ventilation needs - wet air, psychrometric diagram (Mollier) - Air-conditioning: Chillers, Room Air Cooling, Air handling Units - Free Cooling - Technical Installations for low energy or passive buildings Lab1 Sessions PhD-students & lab engineers) Thermal Comfort Heat Flow Meter Thermography Lighting Blower Door Software Lesosai Thermal Bridges - catalogue</p>
Modalité d'enseignement:	Lecture + Lab. English, lecture and syllabus in English; but partly referring to literature in "French" language part 1 & part 2 are lectures, lab-sessions are theory & demonstration of measuring devices
Langue:	Anglais

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Obligatoire:	Oui
Evaluation:	always 1 end-of-semester exam. By default in written form; an oral exam form may be chosen by the teacher depending on the number of students or external constraints / It's split in part1, part 2 and lab1 or for MSCE in part 1 and lab1. But in all cases one mark only for the complete exam.
Remarque:	Part I: <ol style="list-style-type: none">1. Roulet, Santé et qualité de l'environnement intérieur dans les bâtiments, 2004, Lausanne2. Multiple handouts during the lessons3. W. Feist, das Niedrigenergiehaus, C.F. Müller, 19984. RWE Bau Handbuch, VWEW Energieverlag, 2004 Part II: Script Part Lab. Sessions : Hand-out's access to LESOSAI for one lab session
Professeur:	MAAS Stefan, SCHOLZEN Frank

Structural Dynamics

Module:	Structural Dynamics (Semestre 2)
ECTS:	4
Objectif:	The students know the theoretical foundations of discrete and continuous (longitudinal, transversal and torsional in 1D continua/structures, wave propagation in thin-walled structures) vibration problems and associated single- and multiple-degree of freedom systems. They can develop suitable models of two- and three-dimensional frame structures and know how to apply methods for the solution of the resulting system of equations of motion. The students know typical sources of structural excitation in civil and mechanical engineering and can perform first analyses based on the code (DIN).
Course learning outcomes:	The students will be able to: <ul style="list-style-type: none">· Develop eligible structural models for selected constructions;· Perform the associated vibration analysis and its critical interpretation; and· Identify suitable modifications of structural designs in order to meet co-existing criteria such as safety, reliability and resource efficiency.
Description:	Periodic and non-periodic vibration; modelling of rigid-body systems and continuous flexible structures (rods, beams, torsion, frame structures, plane structures); derivation of the set of equations of motion: synthetic and analytic method; rotational motion/constrained motion; linearisation and solution of the equation of motion; free and forced vibration of undamped and damped structures; modal analysis and modal synthesis; modal reduction. Exemplarily, the following engineering applications are discussed in detail:

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

- earthquake engineering: seismic excitation, response spectrum method,
- wind engineering: wind and fluid flow excitations, flow-induced vibrations,
- bridge engineering: dynamic railway excitation,
- damping: active and passive damping devices
- rotor dynamics, aerodynamic forces: application to wind turbines.

Modalité d'enseignement: Lectures

Langue: Anglais

Obligatoire: Oui

Evaluation: Semester project with presentation and oral questioning: 40 %
Semester project with report: 60 %

Remarque:

- Lecture slides, notes on blackboard, computer framework using MATLAB;
- R. R. Craig: Structural Dynamics. John Wiley & Sons, New York (1981)
- S. D. Timoshenko; D. H. Young; W. Weaver: Vibration Problems in Engineering. Wiley, New York (1974)
- R. Gasch; K. Knothe: Strukturdynamik. Springer-Verlag, Berlin [in German]

Professeur: ZILIAN Andreas

Transport Systems Analysis

Module: Transport Systems Analysis (Semestre 2)

ECTS: 4

Objectif: This course provides the fundamentals of traffic and transport systems theory: it aims at understanding and managing the relationship between demand for mobility and the various transportation systems and explains how these lead to economic and societal problems such as congestion, pollution, etc.

The goal is to provide a broad view of transportation systems analysis covering both private and public transport systems, and to complement this overview with a discussion of aspects like congestion analysis and management, intelligent transportation systems, traffic data collection methods, and new sustainable options (travel sharing, multi-modality, e-cars, etc.).

Course learning outcomes:

1. Provide the student the student with a basic knowledge of transportation systems and to get in touch with the most relevant issues addressed by transportation systems theory.

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

2. Introduce the student to theoretical and practical tools to analyse traffic and transport systems, to solve traffic management and infrastructure planning and design problems.

Description:

1. Introduction to transport systems analysis and transport planning and management;
2. Supply systems and traffic flow theory: Urban and motorway systems, definition of capacity, Macroscopic models (fundamental diagram approach);
3. Demand and Travel behaviour: Basics of random utility theory, decision making processes, choice set generation; 4-stage modelling, OD estimation from traffic data
4. Traffic assignment and equilibrium: Traffic assignment processes; equilibrium principles;
5. Planning and scheduling of Public Transport: Timetabling, railway capacity, safety systems, real-time rescheduling and management; PT planning and design, sustainable mobility, multimodal networks
6. Infrastructure planning and design: Basics of transport economics, pricing problems, road maintenance strategies, design and planning of new infrastructures

Theme:

1. The complexity of modelling transportation networks is elaborated in detail, from the analysis of the demand to the arising of congestion problems and how to mitigate them.
2. Different management solutions are described in the second part of the course to learn how to reduce transportation costs, and seek sustainable mobility targets.

Modalité d'enseignement:

Lecture

Langue:

Anglais

Obligatoire:

Oui

Evaluation:

Written Examination

Remarque:

Course handouts, course notes.

Cascetta E. Transport Systems Analysis. Springer (complementary reading)

Ortuzar J. and Willumsen P. Transport Modelling. Wiley (complementary reading)

Professeur:

VITI Francesco

Transport Systems - Project

Module:

Transport Systems - Project (Semestre 2)

ECTS:

2

Langue:

Français

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Obligatoire: Oui
Professeur: VITI Francesco

Engineering Surveying

Module: Engineering Surveying (Semestre 2)

ECTS: 5

Objectif: The general aim is to provide a module for students of the Master in Civil Engineering to introduce them to and raise the awareness of the field of engineering surveying (ES) with a focus on megastructures and sustainability. More specific aims of the module include:

- to provide knowledge and understanding of current theories and developments,
- to encourage an understanding and critical awareness of observation techniques and their associated error budgets,
- to enhance understanding of the relevant design and management processes, and
- to gain experience in the analysis of spatial information in combination with practical Geographical Information Systems (GIS) skills.

Course learning outcomes: The students will obtain the

- 1) knowledge and understanding of
 - scientific concepts, principles and theories appropriate to ES relevant to megastructures,
 - advanced techniques appropriate to the application of technologies in ES and geospatial data analysis;
- 2) intellectual skills: ability to
 - select and apply mathematical methods in modeling, analysis, and problem-solving,
 - select and apply scientific and technological principles to model, analyze and solve problems;
- 3) subject-based practical skills: ability to
 - use relevant information technology,
 - carry out field surveys and geospatial analysis using GIS;
- 4) skills for life and work
 - communication skills,
 - problem-solving skills,
 - analytical skills,
 - knowledge application.

Description: Geodetic Principles – Dfinitions, Coordinate Systems and Reference Systems, Map projections
Vertical Control – Instruments, Principles, Error sources

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Angle and Distance Measurements – Instruments, Principles, Corrections, Reductions

Analytical Methods 1 – Statistical Principles, Errors and Error Propagation

Analytical Methods 2 – Least-squares adjustment

Geodetic computations 1 – Coordinate Computations, Traversing

Geodetic Computations 2 – Transformations, Areas and Volumes

Satellite Positioning – Principles, Observations, Error and Positioning

Geographical Information Systems – Introduction and Applications

Setting Out – Basic and advanced procedures, coordinates, curves and grids

Photogrammetry and 3D Imaging 1 – Laser Scanning and 3D Point clouds

Photogrammetry and 3D Imaging 2 – Photogrammetry and 3D Image Processing

Themes: 1. Megastructures & 2. Sustainability:

1. All chapters will have a special focus on megastructures and their associated complexities in terms of geodetic instrumentation and systems, analytical methods, their applications and related management systems.

2. GIS technology provides the means for planning, managing, analysing and visualizing data associated with developing and managing infrastructure, especially of megastructures. Hence, it plays an ever increasing role as a tool in engineering and construction in a world with limited resources.

**Modalité
d'enseignement:**

Lecture + Practical

Langue:

Anglais

Obligatoire:

Oui

Evaluation:

1. Project Work

and

2. Written Examination

Remarque:

Uren, J. and Price, W.F.: "Surveying for Engineers", 5 thEd., Palgrave Macmillan, 2010.

Schofield, W. and Breach, M.: „Engineering Surveying", 6th Ed., Butterworth-Heinemann, Oxford, 2007.

Kavanagh, B.F.: „Surveying with Construction Applications", 6th Ed., Pearson Prentice Hall, Upper Saddle River, 2007.

Witte, B. and Sparla, P.: „Vermessungskunde und Grundlagen der Statistik für das Bauwesen", Wichmann Verlag, Berlin-Offenbach, 2011

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Benning, W.: "Statistik in Geodäsie, Geoinformation und Bauwesen", Wichmann Verlag, Berlin-Offenbach, 2009

Möser, M et al.: „Handbuch Ingenieurgeodäsie - Ingenieurbau“, Wichmann Verlag, Berlin-Offenbach, 2008.

Bill, R. and Resnik, B.: "Vermessungskunde für den Planungs-, Bau- und Umweltbereich", Wichmann Verlag, Berlin-Offenbach, 2009

Van Sickle, J.: "GPS for Land surveyors", CRC Press, 2008.

Hofmann-Wellenhof, B., Lichtenegger, H., Waskle, E.: "GNSS – Global Navigation Satellite Systems: GPS, Glonass, Galileo and more", Springer, 2007.

Heywood, I., Cornelius, S. & Carver, S. (2006) An introduction to geographical information systems, 3rd Edition, Prentice Hall.

Longley, P.A., Goodchild, M., Maguire, D.J., Rhind, D.W. (2010), Geographic Information Systems and Science, 3rd Edition, Wiley

Professeur: TEFERLE Felix Norman

Sustainable Water and Resources Management

Module: Sustainable Water and Resources Management (Semestre 2)

ECTS: 5

Objectif: Currently, a transition is taking place in Europe towards an increasing awareness of the impact of our behavior on the environment. Instead of unrestricted use of fossil fuels, the focus is slowly shifting towards minimizing energy consumption or using renewable sources of energy with the purpose to reduce carbon emissions. The current configuration of the urban water cycle is, from and energy use perspective, not as sustainable as it could be. For example, more than 85% of the energy input in the total urban water cycle (drinking water production, distribution, use in households, wastewater collection and treatment) is used to heat our water. Much of this energy is simply wasted and ultimately discharged to the environment. The creation of a system with a sustainable use of energy within the urban water cycle is necessary.

This course provides the fundamentals of sustainable technologies in wastewater and sludge treatment: it aims at understanding and managing the main processes that are necessary, the consumption of energy to conduct these processes in wastewater treatment plants as well as the possibilities of energy production from wastewater and sludge. The main goal is to provide a broad view of conventional wastewater treatment technologies and new sustainable options.

In addition to the theoretical part of this course, case studies will be presented by internal and external experts, simulation tools used in practice are provided to get a deeper knowledge in interactions between different treatment processes. The course is complete by two field trips to national and international enterprises dealing with sustainable wastewater and sludge treatment technologies.

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Course learning outcomes:	<ol style="list-style-type: none">1. Provide the student with a basic knowledge of transportation systems and to get in touch with the most relevant issues addressed by transportation systems theory.2. Introduce the student to theoretical and practical tools to analyse traffic and transport systems, to solve traffic management and infrastructure planning and design problems.
Description:	<ol style="list-style-type: none">I. State of the art in wastewater and sludge treatmentII. Future challenges<ul style="list-style-type: none">• Climate change• Demographic development• Shortage/limitation of Resources (energy, phosphorus)III. Emerging pollutants: Micropollutants in wastewaterIV. Resources in Wastewater<ul style="list-style-type: none">• Energy (consumption + production)• Nutrients (recovery)• Water (reuse)V. Ressource-oriented concepts in wastewater treatment
Modalité d'enseignement:	Lecture
Langue:	Anglais
Obligatoire:	Oui
Evaluation:	Written Examination + Computer-aided essay
Remarque:	<ul style="list-style-type: none">• Metcalf & Eddy: 'Wastewater Engineering, Treatment and Reuse'• Water Environment Federation 'Energy Conservation in Water and Wastewater'• Cao 'Mass flow and Energy Efficiency of Municipal Wastewater Treatment Plants'• Environmental Protection Agency: 'An Energy Management Guidebook for Wastewater and Water Utilities'• Asano 'Wastewater Reclamation and Reuse'• Khanal 'Anaerobic Biotechnology for Bioenergy Production: Principles and Applications'
Professeur:	HANSEN Joachim

Managerial Accounting

Module:	Managerial Accounting (Semestre 2)
ECTS:	3
Objectif:	<p>This course is an intensive introduction to the preparation and interpretation of financial information for investors (external users) and managers (internal users) and to the use of financial instruments to support system and project creation.</p> <p>The course adopts a decision-maker perspective on accounting and finance with the goal of helping students develop a framework for understanding financial, managerial, and tax reports.</p>

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

The course will also explore how cost-volume-profit relationships and incremental analysis provide managers the information to support their decision-making.

Course learning outcomes:

This course will enable you

- To acquire an overview of the use of accounting data by managers for financial and operational planning and control.
- To evaluate the organizational role of management accountants and describe accounting systems used by manufacturing businesses.
- To acquire a basic knowledge in the techniques and procedures of costing systems, profit planning, and the collection and use of cost data in decision making.
- To develop a basic foundation in the concepts of cost behaviour and cost systems design.
- To understand basic managerial and cost accounting concepts such as cost-volume-profit, budgeting, product costing and cost behaviour.
- To prepare, use and evaluate budgetary data.
- To evaluate capital expenditure decisions using discounted cash flow
- To analyze Capital Investment Alternatives.
- To apply and interpret basic financial statement analysis.

Modalité d'enseignement:

The course will be delivered online through a series of Webinar lectures, slide presentations, case studies, and on-going participation in discussion forums.

All lecture slides, Connect Account/Submission assignments and forum topic participation requirements will be provided on a weekly basis. Each student should consult the Moodle platform daily for announcements.

Langue: Anglais

Obligatoire: Oui

Evaluation: Assessment will be based on Weekly Connect/Submission Assignments (10% or 12pts), Weekly Participation in Forums (10% or 12pts), Group Case Studies (10% or 12pts), a Midterm Exam (20% or 24pts), and the Final Exam (50% or 60pts).

Weekly Assignments

All weekly assignments will be communicated with a view that enough time is given for the work to be completed. Instructions on your forum participation, Connect account/submission requirements will be communicated. The Weekly Connect/Submission assignment is 20% or 24pts and the Forum Participation is also 20% or 24pts of the total assessment score.

Group Project

Case Studies in groups will be assigned. 10% or 12pts of the total assessment score.

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Midterm Test

The midterm Test will be a summary review of the weekly assignments based on textbook chapters and material covered in class. The midterm exam will take place online and will be 20% or 24pts of the total assessment score.

Final Exam

The final exam will be a summary review of the weekly assignments based on textbook chapters and material covered in class. The final exam will take place on campus and will be 50% or 60pts of the total assessment score.

Attendance

Attendance is part of the forum participation mark. 80% of lecture attendance on courses is compulsory for obtaining the ECTS units related to that course and module. Attendance is recorded as meeting the forum participation rule of 2 separate posts 2 times per week.

Note: Instructor reserves the right to change the Weekly Assignments, the Group Project or Quizzes during the semester.

Remarque:

Required Text:

Garrison, R., E. Noreen, and P. Brewer. Managerial Accounting, 2nd Edition New York: McGraw-Hill/Irwin

with Connect Account: ISBN-13 9780071221085

Indicative Reading:

Illustrative texts and articles include:

- A Bhimani, Strategic Finance, Strategy Press, (2008)
- C Horngren, A Bhimani, S Datar & G Foster, Management and Cost Accounting, FT/Prentice Hall (2008)
- A. Bhimani, Contemporary Issues in Management Accounting, Oxford University Press (2006)
- Emsley, Redesigning variance analysis for problem solving, Management Accounting Research (2001) pp.21-40
- Davila, T. and Wouters, M. (2005) "Managing budget emphasis through the explicit design of conditional budgetary slack", Accounting, Organizations and Society: 30, 587-608
- Miller & O'Leary, Managing operational flexibility in investment decisions: the case of Intel, Journal of Applied Corporate Finance (2005), pp. 87-93.
- Hall, M. (2008). The effect of comprehensive performance measurement systems on role clarity, psychological empowerment and managerial performance. Accounting, Organizations and Society, 33(2-3), 141-163.

Professeur:

LOPATTA Kerstin



Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Underground structures Advanced Soil Mechanics

Module: Underground structures Advanced soil mechanics (Semestre 2)

ECTS: 3

Objectif: The target is that the students will learn more about the following techniques:

- Ground improvement
- Tunnelling
- Shallow foundations
- Pile foundation
- Walls
- Anchors, struts and floors

Course learning outcomes:

- Students must know the most important techniques in the field of geotechnical engineering, their advantages and disadvantages.
- Students must be able to make simple hand calculations of these techniques for a short geotechnical design.

Description:

- Soil improvement
- Tunnelling
- Shallow foundations
- Pile foundations
- Underground megastructures
- Building pit
- Walls an lateral stress
- Anchors, struts and wales
- Floors
- Global stability and failure
- Dewatering
- Safe design



Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Langue: Anglais
Obligatoire: Oui
Evaluation: Written examination
Remarque: Book " Advanced Soil Mechanics "
PDF's from presentations
Professeur: WITTKKE Stefan

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Semestre 3

Advanced (Design) project / Case Study

Module: Advanced (Design) project / Case Study (Semestre 3)

ECTS: 9

Objectif: In this project the students will learn to implement and combine their knowledge and skills obtained from the technical courses (steel, concrete, etc.), the management courses (project management, managerial accounting/entrepreneurship) and also the skills in presentation and scientific writing. They have to develop and optimise the structural design of a real project considering the building construction method within their sustainability and the boundary conditions of the project.

Course learning outcomes: 1. The student is able to do scientific and engineering analyses for the structural design and management of an important project and will develop realizable technical solutions and construction details for it (problem analysis – solver – solution).

2. The student can implement the main themes related to megastructures and sustainable engineering.

3. The student is able to organise the project work and to respect the time schedule of it, looking at the capacities and character styles available in the group.

4. The student is able to fulfil the set tasks by an independent elaboration.

5. The student is able to present this work in scientific writing and presentation.

Description:

- Project management
- Project analyses
- Project planning
- Project implementation
- Project design
- Project presentation

Themes: 1. Megastructures & 2. Sustainability:

The students have to implement the two themes Megastructures & Sustainability into their project.

Langue: Anglais

Obligatoire: Oui

Evaluation: Report & Presentation

Remarque: All professors of civil engineering

Professeur: WALDMANN Daniele

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Prestressed Concrete Structures

Module:	Prestressed Concrete Structures (Semestre 3)
ECTS:	5
Objectif:	The course enables the students to design and reinforce prestressed concrete elements. The student will be able to apply procedures to recognize the structural behavior of prestressed elements with a special reference to creeping and shrinkage. For this type of construction, the student will acquire basic knowledge for the dimensioning and design with respect to durability and ultimate limited state.
Course learning outcomes:	At the end of this course the students will be able to design a complete bridge made out of a pre-stressed concrete.
Description:	§Notations et définitions §Materials and their properties §Load case pretensioning and the reaction of the cross section §Structural analysis of the cross section of prestressed elements in function of the internal forces §Study of the deformations of pre-stressed elements in function of time
Langue:	Anglais
Obligatoire:	Oui
Evaluation:	Written examination, 90 min
Professeur:	WALDMANN Daniele

Steel & Composite Structures 2 – Bridges

Module:	Steel & Composite Structures 2 – Bridges (Semestre 3)
ECTS:	4
Objectif:	In this lecture, the learning targets concern steel structures, which serve special Architecture to realise the so-called "High Tech Architecture". (One of the very first and well known buildings concerning this type of Architecture was the "Centre Pompidou" in Paris.) The Student will get the basic knowledge to develop in collaboration with the Architect challenging structures for challenging buildings. That means, beyond the already given knowledge in steel, structural façade structures, combined steel-glass structures, cable supported structures and membrane structures will be tackled. In addition, the basic knowledge to assess the sustainability of the developed structures will be given.

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Course learning outcomes:

1. The student is able to develop in combination with the architect and the façade engineer systems like double-skin façades, structural glazing façades and element-façades. He is able to proof the structural load bearing capacity of the structure, especially of the glass structure and the supporting steel structure.
2. The student is capable to design membrane structures and cable structures. He constructs all relevant details concerning the membrane fixings, the load bearing structures and the anchorage structure.
3. The student is able to judge the sustainability of the architectural solution by analysing the CO₂-equivalent, especially concerning the used steel products. He is able to discuss with professionals the advantages and disadvantages of the different solutions concerning the energetic behaviour of the building.

Description:

1. Structures in Steel and Glass
 - Introduction
 - Exemplification of worldwide well known buildings with challenging steel-glass structures
 - Construction, design and proof of steel-glass façade structures
 - Construction, design and proof of horizontal glass structures of the building envelope
2. Cable and Membrane Structures
 - Introduction
 - Exemplification of worldwide well known buildings with cables and membranes
 - Structural analysis
 - Structural and constructional details
3. Sustainability
 - Introduction
 - Criteria of judgement for sustainability
 - Life-Cycle evaluation, recycling, deconstruction, reuse
 - Determination of CO₂-equivalent of steel

Langue: Anglais

Obligatoire: Oui

Evaluation: (1) Obligatory homework with grades
(passed homework (Contrôle Continu) is precondition for examination)
(2) Written examination

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Professeur: ODENBREIT Christoph, AZIM AZARY Ali

Numerical soil mechanics

Module: Numerical soil mechanics (Semestre 3)

ECTS: 4

Langue: Anglais

Obligatoire: Oui

Professeur: RICA Shilton

Composite Structures & Fire Design

Module: Composite Structures & Fire Design (Semestre 3)

ECTS: 5

Description:

- Fundamentals of fire development
- Physical basics of heat transfer
- Behavior of building materials under high temperatures
- Actions and effects in fire- Natural fire curve and ISO standard fire
- Design of structural elements in fire- Structural components and details
- Constructive fire protection
- Examples of executed projects

Modalité d'enseignement: Lecture + project

Langue: Anglais

Obligatoire: Oui

Evaluation: WRITTEN EXAM and HOMEWORK

75% of the grade by the written exam and 25% by homework

Professeur: SCHÄFER Markus, YOLACAN Taygun Firat

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Scientific writing and presentation skills

Module:	Scientific writing and presentation skills (Semestre 3)
ECTS:	3
Objectif:	<p>This course aims to give students the background and confidence to write effective engineering reports and papers.</p> <p>They will learn the fundamentals of effective scientific and professional writing.</p> <p>Presentation skills, verbal and non-verbal communication as well as specific documents such as a CV, cover letter, abstract and executive summary will be covered.</p>
Course learning outcomes:	<p>As a result of this course the students should be able to:</p> <ul style="list-style-type: none">- Write an engineering or scientific paper in regards to their structure, coherence, conciseness and expressing the core idea.- Evaluate own writing and the writing of others.- Deliver a professional or scientific presentation.- Write a professional CV and cover letter, as well as learn how to prepare themselves for a job interview
Description:	<p>Section 1. Professional writing</p> <ul style="list-style-type: none">· Professional writing and professional communication<ul style="list-style-type: none">o The CVo The cover lettero The job interview <p>Section 2. Presentation skills</p> <ul style="list-style-type: none">· Write presentations in academic and professional context· Verbal and non-verbal communication during the presentation <p>Section 3. Scientific report writing</p> <ul style="list-style-type: none">· Engineering reports· The abstract and the executive summary
Modalité d'enseignement:	Lecture



Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Langue: Anglais
Obligatoire: Oui
Professeur: MOLINA Angel

Master of Science in Civil Engineering - Megastructure Engineering with Sustainable Resources

Semestre 4

Master thesis

Module:	Master thesis (Semestre 4)
ECTS:	30
Langue:	Anglais
Obligatoire:	Oui