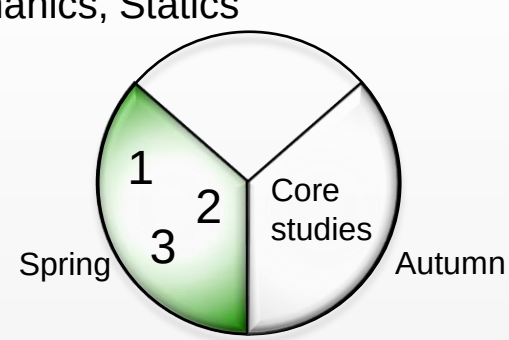
Master courses of Steel Structures

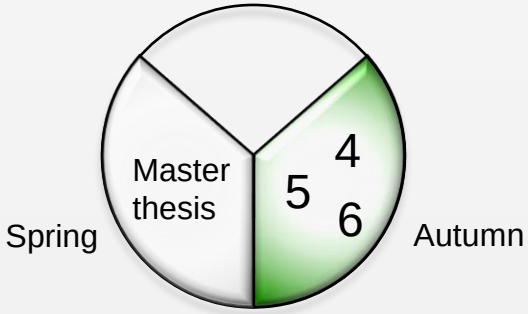
STEEL STRUCTURES – COURSE MODULES

- Master course module (25 cr.)
- Bachelor level: FEA, Steel Structures I, Strength of materials, Mechanics, Statics

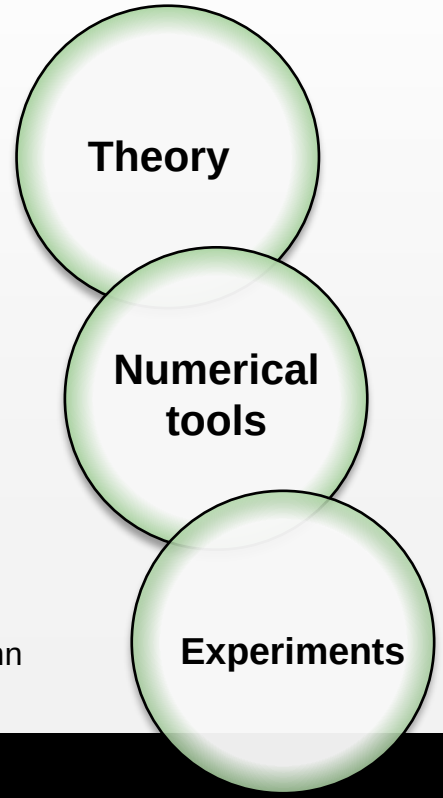
1. **BK10A4000** Design of Advanced Plate and Shell Structures
2. **BK80A2303** Steel Structures II
3. **BK80A1302** Applications for FE-method for Steel Structures
4. **BK80A3101** Experimental Research of Welding and Structures
5. **BK80A3000** Integrated Design and Fabrication of Welded Structures
6. **BK80A1402** Fatigue Design



Year 1



Year 2



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BK80A1302 ADVANCED PLATE AND SHELL STRUCTURES (5 CR., MS-1)

Learning outcomes:

After having passed this course module, the student is able to:

- recognize different type of plate and shell structures and their application in mechanical engineering
- understand the behavior of plates and shells in term of strength and capacity and can design simple structures and analyze fabrication processes
- choose purposeful solution in terms of design, fabrication and material (steels, other metals and composites) for certain application and can design simple constructions
- design the fabrication such as bending, forming and cutting of plate as a workshop processes
- understand and utilize the capability of FEA in design and fabrication on plate and shell structures
- design and fabrication of cell structures (laser, 2D-printing and extruding-processes)

Content

During the course the student will become familiar with:

- basic theories of plate and shell structures
- design of plate and shell structures considering stiffness, vibrations, stability and simple plastic limit state
- simulation of fabrication, such as brake pressing, mechanical cutting and punching of plate
- fabrication possibilities of plate and shell structures
- laboratory tests of plate and shell structures to compare the results with analytical and FEA.

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BK80A1302 APPLICATIONS FOR FE-METHOD FOR STEEL STRUCTURES (5 CR., MS-1)

Learning outcomes:

After having passed this course module, the student is able to:

- model the typical industrial structures
- choose an appropriate element type for the considered structure
- choose an appropriate analysis type for the considered structure
- verify the FE-analysis results by analytical computations

Content

During the course the student will become familiar with:

- linear & non-linear analysis types
- vibrations of structure
- stability behaviors of structures
- sub-modeling techniques
- manufacturing requirements in association with numerical FE analyses

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BK80A2302 STEEL STRUCTURES II (5 CR., MS-1)

Learning outcomes:

After completing this course, students can design welded structures for demanding applications, also considering fabrication requirements. This signifies that they are able to:

- choose the purposeful analyzing method for fatigue design of welded joints
- design of the plated (welded and cold formed) structures considering stability
- design the structures and joints by using plastic limit state method
- evaluate the risk of brittle fracture, especially for arctic structures
- design of beams considering also torsion, warping, distortion, shear lag, etc.
- optimize structures, especially considering the potential of high and ultra high strength steels
- design of bolted connections

Content

During the course the student will become familiar with:

- The theoretical background for the fatigue design of welded joints.
- Theoretical background and design (EC3) for buckling of plates, columns and beams.
- Plasticity theory of beams, frames and plates (yield line method)
- Numerical methods for analyzing brittle fracture considering the material properties of welded joints. Theory of thin-walled structures.
- Practical approaches for the design and multi-objective optimization of welded structures, considering global structural behavior and details and usability of high-strength materials.
- Failure modes of mechanical (bolted) joints.

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BK80A3101 EXPERIMENTAL RESEARCH OF WELDING AND STRUCTURES (5 CR., MS-2)

- **Learning outcomes**:

After completing this course, students can design welded structures for demanding applications, also considering fabrication requirements. This signifies that they are able to:

- choose the purposeful analyzing method for fatigue design of welded joints
- design of the plated (welded and cold formed) structures considering stability
- design the structures and joints by using plastic limit state method
- evaluate the risk of brittle fracture, especially for arctic structures
- design of beams considering also torsion, warping, distortion, shear lag, etc.
- optimize structures, especially considering the potential of high and ultra high strength steels
- design of bolted connections

- **Content**

- During the course, the student will become familiar with the experimental testing and analysis of welded structures. This comprises:
  - Designing, analyzing, and preparing studied welded joint
  - executing applied welding process (e.g., GMAW) in practice
  - performing metallurgical investigations (macro-/micro-level analyses, hardness measurements, etc.) for the studied welded joints
  - conducting measurement procedures and analyses of geometrical parameters, residual stresses and strains (e.g., strain gages and DIC), as well as deformations and loads in the structure
  - carrying out the capacity tests (static and fatigue) and analyzing and reporting results
  - systematically reporting and presenting experimental research work

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BK80A3000 INTEGRATED DESIGN AND FABRICATION OF WELDED STRUCTURES (5 CR., MS-2)

- **Learning outcomes**:
- After having passed this course module the student is able to:
  - apply the skills comprehensively learned from the previous steel structure courses for designing and planning production for welded structures or complete member of such structure
  - apply the theoretical knowledge for practical design and fabrication of welded structure
  - have skills to collect design data and use design tools to create a competitive and fabrication friendly construction based on requirements set by end-user
  - design for fabrication (considering the potential and limitations of available fabrication processes) but also understand the background of quality requirements set for fabrication
  - understand the consisting of fabrication costs and design impact on them
  - have encouragement to design and make fabrication plans later in industry, unprompted
  - move this experience to work out the integrated design & fabrication process in practice (in R&D and workshops)
- **Content**
- During the course the student will apply the knowledge acquired in the prerequisite courses, and become familiar with:
  - design of real structure based on available load information, durability requirements and main boundary conditions given by end-users
  - Using practical design tools (analytical and numerical) and optimization approaches to design energy efficient constructions
  - working as a member of group, consisting of design and fabrication experts, for the common goal
  - creating fabrication plan, particularly focusing on the welding process specifications (WPS) for a structure or a complete member of it
  - methods to take into consideration the available workshop facilities when choosing fabrication processes and evaluating fabrication costs
  - practical interactive process between design and fabrication to find a compromising solution considering strength requirements and fabrication costs of critical structural details
  - documentation of design and fabrication plan