Modulbezeichnung:  
Stundenplankürzel:  
(Title)  

Engineering Mechanics  
EngMech

Modulverantwortliche(r):  
(Module responsibility)  

Prof. Dr.-Ing. Manfred Anzinger

Dozent(in):  
(Course teacher(s))  

Prof. Dr.-Ing. Eckhard Hoffmann

Sprache:  
(Language of instruction)  

English

Zuordnung zum Curriculum:  
(Degree programme)  

Bachelor Engineering and Management, Semester 1

Lehrform/SWS:  
(Teaching method / Hours per week (SWS))  

Maximum group size: 50 students  
lectures and exercises / 4 SWS

Arbeitsaufwand:  
(Workload)  

Presence time for lectures and exercises: 60 hours  
Self-studies, preparation of lectures and exam: 90 hours

Kreditpunkte:  
(Number of ECTS credits)  

5 ECTS

Voraussetzungen:  
(Prerequisites)  

Basis knowledge and fundamentals in mathematics and physics

Inhalt der einzelnen Vorlesungen  
(Content of lectures)  

1. **Lecture: Introduction to statics**  
   - General introduction; Classification of mechanics; SI units; definition of a force as a vector quantity; component as rigid body  
   - Axioms of statics; definition of equilibrium; law of action equals reaction; principle of transmissibility; parallelogram law of forces; definition of superposition.

2. **Lecture: Forces and moments**  
   - The moment of a force; cross product; position vector; sign convention (cork screw rule)  
   - The couple; reference point and its selection; parallel displacement of forces; displacement moment; moment w/ respect to a pole; mathematical treatment of moments in a given coordinate system.  
   - Exercises
3. **Lecture: Graphic and analytical solutions**
   - Graphic solutions for static problems; layout plan; plan of forces; determination of the resultant force; intermediate resultants; resultant in coplanar, parallel and general systems of forces; application of the axioms of statics.
   - Analytical solutions for concentrated forces; determination of the resultant moment; definition of leverarm; finding both the zero crossing and the y-axis intercept of a resultant within a coordinate system.
   - Exercises

4. **Lecture: Supports**
   - Distributed forces; line loads
   - Supports and bearings; simple, hinged and fixed supports; valence of supports; simple supported beam; cantilever beam; degrees of freedom; constraints of a system
   - Statically determinate and statically indeterminate systems; principle of isolation, method of section; free body diagram; support reactions
   - Exercises

5. **Lecture: Systems in equilibrium**
   - Equilibrium systems; graphic solutions for three unparallels forces and four unparallels forces (Culmann’s procedure); formulation for equilibrium conditions; analytical solutions for systems in equilibrium.
   - Bar and beam; truss and single node; rope and pulley block; how to recognise and calculate of those components in a complex structure
   - Exercises

6. **Lecture: Friction**
   - Friction; static and kinetic friction; Coloumb’s law of friction; friction angle and friction cone; limit case of static friction
   - Friction on the inclined plane; friction angle; upward and downward movement; self locking;
   - Rolling resistance
   - Exercises

7. **Lecture: Introduction of strength of materials**
   - Strength of materials; basic terms and calculations; rigid and real bodies; elastic and plastic deformation
   - Introduction of stress: tensile stress, compression, contact pressure, bending, torsion, buckling, combined loads; difference between both normal and shear stress
   - Introduction of strain; change of shape; connection between stress and strain; constitutive law (law of
materials, Hooke’s law)
• Material constants: stress-strain-diagram; Young’s modulus E, ultimate tensile strength (UTS); yield strength; lateral contraction; Poisson’s ratio; shear modulus G; correlations between those material constants.
• Thermal stress and strain: thermal expansion coefficient; strain restriction and free unrestricted strain
• Exercises

8. **Lecture: Stress resultants**
• Bending; symmetric and unsymmetric bending; stress resultants: normal forces N, shear forces Q and bending moments M_b; sign conventions for positive and negative face
• Imaginary cuts/sections on both simply supported and cantilever beams
• Stress resultants for both concentrated forces and distributed forces (line loads); derivation of formulae for N(x), Q(x), M_b(x); determination of integration constants by appropriate boundary conditions
• Exercises

9. **Lecture: Bending stresses at beams**
• Center of gravity, calculation of centroids in complex planar shapes; neutral fiber; correlation between bending moment and outer fibre stress; calculation of bending modulus; flexural rigidity
• Area moment of inertia; axial and polar area moments; paralles-axis theorem (theorem of Steiner); calculation of area moments of inertia for composite areas
• Calculation of bending stresses at beams w/ complex shapes
• Exercises

10. **Lecture: Shear and torsional stresses**
• Special features of shear stress; definition of classified shear stress (complementary shear stress); shear stress profiles (rectangular and circular cross-sections)
• Torsional stress; derivation of both torsional stress at circular sections and angle of twist;
• Torsion at thin-walled, closed cross-sections; derivations of Bredt’s 1st and 2nd formula; torsion at open cross sections; torsion at any cross sections
• Exercises

11. **Lecture (optional)**
• Buckling
12. **Lecture: Combined loads and strength hypotheses**
   - Combined loads: correlation between normal and shear stresses; uniaxial stress state upon both tension and torsion
   - Superposition of bending and tension/compression
   - Unsymmetric bending; superposition of bending on two planes
   - Strength hypotheses: maximum normal stress hypothesis; maximum shear stress hypothesis (Tresca theory); maximum distortion energy hypothesis (von-Mises-hypothesis); equivalent stress
   - Exercises

13. **Lecture: Long-life-fatigue strength**
   - Long-life fatigue strength; differentiation between static and dynamic fatigue strength; Wöhler-curve (S-N-curve)
   - Load cases according to Bach: stationary, pulsating and alternating loads
   - Long-life fatigue strength diagram (Smith diagram); stress concentration factor $\alpha_k$; lines of flux model; fatigue notch factor $\beta_k$; derivation of different effects on real component strength
   - The shape strength diagram for components
   - Exercises

14. **Lecture: Miscellaneous**
   - Review
   - Presentation of former exam tasks

**Studien-/Prüfungsleistungen:**
(Assessment method(s))

**Written Exam**

**Literatur:**
(Recommended reading)

- Lecture notes (script);