Strength of Materials

1. **Course number and name:** 020RDMES1 Strength of Materials

2. **Credits and contact hours:** 6 ECTS credits, 3x1:15 contact hours per week

3. **Name(s) of instructor(s) or course coordinator(s):** Ali AL Shaer

4. **Instructional Materials:** PowerPoint slides – Lab experiments

   Textbooks/References:
   - Mechanics of Materials. R. C. Hibbeler, tenth Edition, Prentice Hall, ISBN-13 978-0134319650.
   - Mechanics of Materials. Roy R. Craig, JR., 4th Edition, Wiley, ISBN-13 978-1119612384.

5. **Specific course information**
   a. **Catalog description:**
   This course develops the phenomena dealing with a deformable solid subjected to a system of external loads: fundamental hypotheses of the theory of beams and elasticity, geometric characteristics of sections, types of stresses, generalized Hooke's law, axial stresses (mechanical stresses, thermal stresses, and deformations), bending of beams and transverse shear (normal stresses, shear stresses, and displacements), torsion of cylindrical members (stresses, deformations), bending moments and shear force diagrams, the state of stress in systems under combined loadings and the analysis of stresses in the walls of thin pressure vessels. It also deals with the calculation of principal stresses, maximum in-plane shear stress and absolute maximum shear stress. In addition, this course leads students to understand the different static failure criteria for ductile and brittle materials. Students will be brought to deal with tensile test on a steel reinforcing construction bar, compressive test on a cylindrical concrete specimen, and twist tests on steel, brass, and copper specimens.

   b. **Prerequisite:** Statics for Mechanical Engineering (020STMNI4 or 020STMCI4).

   c. **Required** for ME students.

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
   A student who successfully fulfills the course requirements will have demonstrated an ability to:
   - Determine the internal resultant loading in a deformable body, calculate and understand the concepts of stress and strain and show how they can be related by the mechanical properties of materials.
   - Determine the normal stress and the related deformation in axially loaded members and solving statically indeterminate axially loaded problems.

- Determine both the stress distribution within the member and the angle of twist when the material behaves in a linear elastic manner of circular or tubular shafts and discuss statically indeterminate analysis of shafts and tubes.
- Establish the bending moment and shear force diagrams which provide a useful means for determining the maximum shear force and moment in a member and specify where these maximums occur.
- Determine the flexural stresses and shear stresses in beams and shafts caused by bending and transverse shear forces for straight members of linear elastic behavior.
- Make analysis of stress developed in thin-walled pressure vessels.
- Discuss the solution of problems where several internal loads (axial load, torsion, bending and shear) occur simultaneously on a member's cross section.
- Compute maximum normal and maximum shear stress and find the orientation of elements upon which they act.
- Study the static failure theories of ductile and brittle materials.

b. PI addressed by the course:

PI	1.3	6.1	6.2	6.3	6.4
Covered	x	x	x	x	x
Assessed	x	x	x	x	x

7. Brief list of topics to be covered

- **Chapter 1: Stress:** Introduction – Review: Free-Body Diagrams and equations of equilibrium – Equilibrium of a deformable body – Average normal stress in axially loaded members – Average shear stress – Allowable stress – Design of simple connections. (4 Lectures).
- **Chapter 2: Strain:** Deformation – Strain – Applications. (2 Lectures).
- **Chapter 3: Mechanical Properties of Materials:** The tension and compression test – The stress-strain diagram – Stress-strain behavior of ductile and brittle materials – Hooke's law – Strain energy – Poisson's ratio – The shear stress-strain diagram. (3 Lectures).
- **Chapter 4: Axial load:** Saint-Venant's principle– Elastic deformation of an axially loaded member – Principle of superposition – Statically indeterminate axially loaded member – The force method of analysis for axially loaded members – Thermal stress – Applications. (4 Lectures).
- **Chapter 5: Torsion:** Torsional deformation of a circular shaft – The torsion formula – Power transmission – Angle of twist – Statically indeterminate torque loaded members – Applications. (3 Lectures).
- **Chapter 6: Bending:** Shear and moment Diagrams – Graphical method for constructing shear and moment diagrams – Bending deformation of a straight member – The Flexural Formula – Applications. (4 Lectures).
- **Chapter 7: Transverse Shaer:** Shear in straight members – The shear formula – Applications. (3 Lectures).

- **Chapter 8: Combined Loading**: Thin-walled pressure vessels – Combined loadings – State of stress caused by combined loading. (4 Lectures).
- **Chapter 9: Stress Transformation**: Plane stress transformation – General equations of plane stress transformation – Principal stresses and maximum in-plane shear stress – Mohr's circle (plane stress) – Absolute maximum shear stress – General case: Three-dimensional state of stress. (3 Lectures).
- **Chapter 10: Static Failure Theories**: Failure theories for ductile and brittle materials – Maximum shearing stress theory – Maximum distortion energy theory – Maximum principal stress theory – Mohr-Coulomb theory – Applications. (3 Lectures).
- **Chapter 11**: Deflections of Beams and Shafts: Elastic curve – Integration method – Superposition method. (3 Lectures).
- **Introducing the « AI » in Mechanics of Materials:** Optimization of bar and beam sections with respect to given design specifications. (3 Lectures).
- **Tension, compression, and twist tests:** Tensile test on a steel reinforcing construction bar – Compressive test on a cylindrical concrete specimen – Twist test on steel, brass, and copper specimens. (2 Lectures).