Foundation of solid mechanics (COE-C2001), (5 cr)
(Mechanics of material)

Responsible Teacher: Prof. Mohamed Noureldin

Course Description:
This course deals with methods for analysis of stress and strain in a three-dimensional elastic body. Lectures about physical behavior and failure criteria of structural materials are provided to study the relation between the analysis result and the actual performance of the structural member.

Course Contents:

Serial	Segment	Contents
1	Tension, Compression, and Shear	Introduction to Mechanics of Materials
2		Normal Stress and Strain, Mechanical Properties of Materials
3		Elasticity, Plasticity, and Creep, Linear Elasticity, Hooke's Law, and Poisson's Ratio
4		Shear Stress and Strain
5		Allowable Stresses and Allowable Loads
6	Axially Loaded Members	Changes in Lengths of Axially Loaded Members
7		Thermal Effects
8		Strain Energy-1 (Nonuniform Bars)
9		Strain Energy-2 (Displacements Caused by a Single Load)
10	Stresses in Beams	Pure Bending and Non-uniform Bending
11		Curvature of a Beam, Longitudinal Strains in Beams
12		Normal Stresses in Beams (Linearly Elastic Materials)
13		Shear Stresses in Beams
14	Analysis of Stress and Strain	Principal Stresses and Maximum Shear Stresses
15		Mohr's Circle for Plane Stress

The contents of the contents above may be changed according to the class conditions.

Intended Learning Outcomes (ILOs):

1. **Material Behavior and Analysis:** Understand the fundamental principles governing material behavior under tension, compression, and shear. Analyze normal stress and strain, and become familiar with mechanical properties, elasticity, plasticity, creep, linear elasticity, Hooke's Law, Poisson's Ratio, shear stress, and strain.

2. **Design Considerations and Safety Factors:** Learn how to determine allowable stresses and loads, ensuring materials are utilized within safe limits, taking into account various mechanical properties and performance criteria.

3. **Behavior of Axially Loaded Members**: Understand the response of materials and structural members to axial loads. Learn to analyze and predict changes in lengths of axially loaded members.

4. **Energy Considerations and Thermal Effects:** Gain proficiency in calculating and applying strain energy in nonuniform bars and for displacements caused by a single load. Understand how temperature changes affect material behavior and structural elements.

5. **Analysis of Beam Behavior:** Understand the stress distribution and behavior of beams under various loading conditions. This includes topics such as pure bending, non-uniform bending, curvature of a beam, and longitudinal strains in beams.

6. **Calculation of Beam Stresses:** Learn to calculate normal and shear stresses in beams made of linearly elastic materials and understand their implications for structural integrity and design.

7. **Advanced Stress and Strain Analysis**: Develop proficiency in analyzing stress and strain in complex scenarios. Understand how to determine principal stresses and maximum shear stresses, providing critical insights into material behavior under different loading conditions.

8. **Application of Mohr's Circle for Plane Stress:** Learn how to employ Mohr's Circle as a powerful graphical tool for visualizing and analyzing plane stress states. This skill is crucial for understanding stress transformations and making accurate engineering assessments.

Prerequisites for the course:

A basic understanding of **mathematics** and fundamental knowledge of **statics** will be required.

Target Audience:

B.Sc. students, Practicing Engineers

Course Organization

- Lecture Period: **24.10.2023** To **7.12.2023**

- Course Language: English

- Lectures: by Prof. Mohamed, on (Tuesdays R1-160a) and (Thursdays R2-253), Time 14.15–16.00

- Exercises: By Teaching assistants (TAs), on (Wednesdays R1-160a) and (Fridays R2-253), Time 14.15–16.00

  Teaching Assistants for the course (Name/ email):
  1. Nuthanon Kittiwatanachod/ nuthanon.kittiwatanachod@aalto.fi
  2. Nguyen Ben / ben.nguyen@aalto.fi
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  5. Nadeem Iqbal/nadeem.iqbal@aalto.fi

- Questions related to assignments and exercise sessions should be sent to TAs.

Course Materials:

- Course materials will be provided on “MyCourses”.
- Recommended textbook: Mechanics of materials, James Gere, 6th edition. (Other textbooks contain similar course materials can be use as reference too)

Home Assignments:

- 5 assignments will be required (each has 10%) = Total is 50%
- TAs will help students for the assignments during the exercise sessions.
- Solution will be provided for each assignment on MyCourses
- Late assignments will **NOT** be accepted.

Evaluation

- **50%** for the Final Exam
- **50%** for 5 assignments (each has 10%)
- **NO** mid-term exam
- Extra marks for active participation in class exercises and discussions.
- Passing score of the course is **50%**

Examination

Final Exam:

1. Course Final Exam will be on **7.12.2023**, from **17.30–20.30**
    - The exam will be on-campus (not online)
    - (Location: Undergraduate Centre, D-sali - Y122).
    - All required formula and equations will be provided in the exam sheet. (Closed-book exam)
    - Laptops, books, or notes are not allowed in the exam. Only properties tables sheets are allowed.
    - Exam scope: all materials uploaded on "MyCourses"
2. Retake Final Exam will be on **23.1.2024**, from **16.30–19.30**
    - The exam will be on-campus (not online)
    - (Location: Mechanical Engineering 1, 326 – 326). Registration period: 24.11.2023 09.00–16.1.2024 23.59
    - All required formula and equations will be provided in the exam sheet. (Closed-book exam)
    - Laptops, books, or notes are not allowed in the exam. Only properties tables sheets are allowed.
    - Exam scope: all materials uploaded on "MyCourses"