Course Information

Division: Mathematics
Course Number: EGR 233
Title: Mechanics of Materials
Credits: 3
Developed by: Spencer Udall
Lecture/Lab Ratio: 3 Lecture/0 Lab
Transfer Status:

<table>
<thead>
<tr>
<th>ASU</th>
<th>NAU</th>
<th>UA</th>
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<tbody>
<tr>
<td>CEE 213, MAE 213, EGR Dept Elective</td>
<td>CENE 253</td>
<td>CE 215</td>
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Activity Course: No
CIP Code: 14.0101
Assessment Mode: Final Exam (28 Questions/100 Points)
Semester Taught: Spring
GE Category: None
Separate Lab: No
Awareness Course: No
Intensive Writing Course: No
Diversity and Inclusion Course: No

Prerequisites
EGR 214 with a grade of "C" or higher

Educational Value
This course is typically required at four-year institutions for civil, mechanical, aerospace/aeronautical engineering, and other majors.

Description
The continuation of engineering mechanics from Statics, this course examines deformable solids, which includes fundamental concepts of stress, strain, elasticity and inelasticity, mechanical properties of materials, material deformations and stresses under axial, bending, torsional, and pressurized loading, deflections and stresses due to mechanical loads and temperature change, composite beam behavior, and methods for finding maximum stresses in combined loading situations.
Supplies
Engineering paper
Ruler
Calculator

Competencies and Performance Standards

1. **Analyze tension, compression, and shear/bending forces on structural members and the resulting deflections and strains.**

   **Learning objectives**
   - What you will learn as you master the competency:
     - Analyze stress, strain, and material properties.
     - Solve problems related to elasticity.
     - Analyze structural loading in terms of allowable stresses and subsequent design.

   **Performance Standards**
   - Competence will be demonstrated:
     - on assigned activities
     - on written exams
     - on a comprehensive final exam
   - Performance will be satisfactory when:
     - Learner calculates normal stresses and strains and relates their relationships to the mechanical properties of materials
     - Learner utilizes linear elasticity, Young's Modulus, Hooke's law, and Poisson's ratio to calculate change in diameter and length as they relate to strain
     - Learner calculates shear stresses and strains in bolted connections and other structural elements
     - Learner calculates allowable stresses and loads

2. **Analyze the stresses and resulting strains and behaviors of axially loaded members.**

   **Learning objectives**
   - What you will learn as you master the competency:
     - Behavior of uniform and non-uniform members under axial stress.
     - Deformation due to temperature change.
     - Thermal and mechanical effects on statically indeterminate members.

   **Performance Standards**
   - Competence will be demonstrated:
     - on assigned activities
     - on written exams
     - on a comprehensive final exam
   - Performance will be satisfactory when:
     - Learner calculates changes in length of axially loaded members, in both uniform and non-uniform members
     - Learner calculates thermal and mechanical deflections and stresses in statically determinate and indeterminate situations.
3. **Analyze torsion and deformations resulting from torsion.**

   **Learning objectives**
   
   *What you will learn as you master the competency:*
   
   a. Analyze torsion in a circular bar.
   
   b. Solve problems related to stresses and strains in pure shear using E and G.
   
   c. Analyze power transmission by circular shafts.

   **Performance Standards**
   
   *Competence will be demonstrated:*
   
   o on assigned activities
   
   o on written exams
   
   o on a comprehensive final exam

   *Performance will be satisfactory when:*
   
   o learner calculates shear stress and strain due to torsion
   
   o learner calculates the angle of twist due to torsion
   
   o learner calculates power transmission by circular shafts

4. **Analyze shear forces and bending moments.**

   **Learning objectives**
   
   *What you will learn as you master the competency:*
   
   a. Analyze beams, loads, and reactions.
   
   b. Draw shear load, shear force, and bending moment diagrams.

   **Performance Standards**
   
   *Competence will be demonstrated:*
   
   o during class discussions
   
   o on a comprehensive final exam
   
   o on quizzes and homework

   *Performance will be satisfactory when:*
   
   o learner solves beams for reaction forces, applied forces, and internal forces
   
   o learner uses shear and moment diagrams or “cut” method to find internal shear forces, and bending moments at any location

5. **Analyze stresses in beams and design beams for bending stresses.**

   **Learning objectives**
   
   *What you will learn as you master the competency:*
   
   a. Analyze pure bending and non-uniform bending.
   
   b. Design beams subject to bending stresses.
   
   c. Analyze shear stresses in beams of various cross sections.
   
   d. Utilize properties of composite beams of multiple materials.

   **Performance Standards**
   
   *Competence will be demonstrated:*
   
   o on assigned activities
   
   o on written exams
6. **Analyze deflections of beams.**

   **Learning objectives**
   
   *What you will learn as you master the competency:*
   
   a. Calculate the deflection and slope of beams by integration of the bending-moment, shear, and load equations.
   
   b. Analyze deflection by the methods of superposition.
   
   c. Utilize deflection methods to solve statically indeterminate beams.

   **Performance Standards**
   
   *Competence will be demonstrated:*
   
   o on assigned activities
   
   o on written exams
   
   o on a comprehensive final exam

   *Performance will be satisfactory when:*
   
   o learner calculates deflection of beams by integrating the bending-moment equation and shear-force and load equations
   
   o learner calculates deflection by applying the method of superposition
   
   o learner uses deflection to find unknown reaction forces in statically indeterminate beams

7. **Analyze principal stresses and maximum shear stresses.**

   **Learning objectives**
   
   *What you will learn as you master the competency:*
   
   a. Analyze plane stress, principal stresses, and maximum shear stresses.
   
   b. Draw Mohr's circle for various problems and demonstrate Hooke's Law for plane strain.
   
   c. Analyze tri-axial stress.
   
   d. Analyze plane strain.

   **Performance Standards**
   
   *Competence will be demonstrated:*
   
   o on assigned activities
   
   o on written exams
   
   o on a comprehensive final exam

   *Performance will be satisfactory when:*
   
   o learner uses plane stress methodology to calculate principal stresses, maximum shear stress, and the angles at which they occur
   
   o learner utilizes Mohr's circle to calculate principal stresses, maximum shear stress, and the
angles at which they occur
   o learner calculates tri-axial stresses
   o learner calculates strain based on principal stresses

8. Analyze the applications of plane stress to pressure vessels, beams, and combined loadings.

Learning objectives
What you will learn as you master the competency:
   a. Analyze stresses and strains in spherical and cylindrical pressure vessels.
   b. Calculate maximum stresses in beams.
   c. Create stress elements for combined loadings on structures.
   d. Analyze the effects of combined loadings.

Performance Standards
Competence will be demonstrated:
   o on assigned activities
   o on written exams
   o on a comprehensive final exam

Performance will be satisfactory when:
   o learner calculates cylindrical and longitudinal stresses and strains in spherical and cylindrical pressure vessels
   o learner calculates maximum stresses in beams, and can identify the locations of these maximum stresses
   o learner creates stress elements based on applied loads and stresses
   o learner calculates principle stresses and maximum shear stress by accounting for the effects of combined loadings

Types of Instruction
Lecture/Discussion

Grading Information
Grading Rationale
Each instructor has the flexibility to develop evaluative procedures within the following parameters.
1. Written exams must represent at least 60% of the final course grade.
2. The Final Exam must represent at least 20% of the final course grade.
3. Other activities may represent at most 20% of the final course grade.

Grading Scale
A  90%-100%
B  80%-89%
C  70%-79%
D  60%-69%
F  Below 60%