MET-2630: ENGINEERING STRENGTH OF MATERIALS

Cuyahoga Community College

Viewing: MET-2630 : Engineering Strength of Materials

Board of Trustees:
January 2023

Academic Term:
Fall 2023

Subject Code
MET - Mech Eng/Manuf Ind Eng Tech

Course Number:
2630

Title:
Engineering Strength of Materials

Catalog Description:
Course designed for students planning to transfer to a 4-year engineering program. Focused on fundamental principles and methods of solid mechanics and their applications. Topics covered include normal, shear, torsional, and thermal stress-strain analysis; generalized Hook's law; bending moment and shear force diagrams; transformation of stress-strain and principle stresses; Mohr's circle for plane stress; state of stress in three-dimension; stress due to combined loading; deflection of beams; plane stress in thin-walled members; strain measurements; analysis of columns; and design principles based on mechanics of solids.

Credit Hour(s):
3

Lecture Hour(s):
3

Requisites

Prerequisite and Corequisite
MET-2610 Statics and PHYS-2310 General Physics I.

Outcomes

Course Outcome(s):
Compute stress-strain due to axial, transverse, torsional, and combined loading conditions of a beam.

Objective(s):
1. Define the tensile/compressive stress and strain and use formulas to calculate stress and strain for simple engineering problems.
2. Define shear stress and strain and use formulas to calculate shear stress and strain.
3. Analyze stress and strain in oblique planes.
4. Calculate thermal stress and strain.
5. Analyze the thin-walled pressure vessels.

Course Outcome(s):
Use properties of materials in engineering design.

Objective(s):
1. Use of stress-strain graphs to extract material properties, such as Young’s modulus, ultimate strength, breaking strength, yield point, % reduction in area.
2. Calculate allowable stress by using the equation for factor of safety.

Course Outcome(s):
Analyze power transmitting shafts for stress and strain.

Objective(s):

1. Calculate torque of shaft for a given power.
2. Calculate torsional stress and strain.

Course Outcome(s):

Understand beam design theory.

Objective(s):

1. Determine the magnitude and location of maximum shear stress and bending moment occur.
2. Analyze the stress of a structure subjected to combined loading using bending formula/Flexure formula.
3. Construct shear force and bending moment diagrams for beams with different loading conditions.

Course Outcome(s):

Calculate deflections of beams due to bending.

Objective(s):

1. Use different methods such as moment-area method, singularity function and integration method to calculate deflection of beam subjected to combined loading.
2. Calculate the maximum deflection and its location of beams with combined loading, and solve statically indeterminate beams for deflection.

Course Outcome(s):

Calculate principle stress and strain.

Objective(s):

1. Develop of Mohr's circle for plane stress due to axial loads, biaxial loads, and combine leads.
2. Transformation of plane stress/strain.
3. Construct shear force and bending moment diagrams for beams with different loading conditions.

Course Outcome(s):

Analysis of columns.

Objective(s):

1. Use Euler column formula to calculate critical loads.
2. Analysis and design of columns for different constraints and use of secant formula.

Methods of Evaluation:

1. Weekly assignments
2. Two periodic exams
3. Final exam-cumulative

Course Content Outline:

a. Introduction to stress
   i. Review of static
   ii. Types of hinges
   iii. Free-body-diagrams (FBD) and equilibrium equations
   iv. Find reaction forces in trusses
   v. Find internal forces
   vi. Stress in members due to axial loading
   vii. Components of stress: Normal stress, shear stress, bearing stress
   viii. Factor of safety
b. Stress and Strain due to axial loading

i. Introduction to stress-strain
ii. Statically indeterminate problems
iii. Poisson's ratio
iv. Stress-strain diagrams
    1. Generalized Hooke's law for tension/compression
    2. Young's modulus, yielding, plastic deformation, breaking strength
    3. Hooke's law for shear stress/strain
v. Poisson's ratio and relationship between Young's modulus (E) and modulus of rigidity (G)
vi. Stress and strain distribution
    1. Saint Venant"s principle
    2. Stress concentration factor

c. Torsion
    i. Torsion of circular shafts
        1. Angle of twist
        2. Torsional stress
    ii. Statically indeterminate shafts
    iii. Power transmission shafts
        1. Stress calculation
        2. Design of shafts
    iv. Thin-walled hollow shafts
d. Bending of beams
    i. Symmetric members in pure bending
    ii. Stress concentration and plastic deformation
    iii. Unsymmetrical bending analysis
    iv. Stress under combined loading
    v. Bending of curved members
e. Shearing stress in Beams
    i. Distribution of stress in rectangular beams
    ii. Horizontal shearing stress
    iii. Longitudinal shear stress
    iv. Shearing stress in Thin-walled member
f. Shear and bending moment diagrams (BMD)
    i. BMD by moment-area method
    ii. BMD by singularity functions
    iii. BMD by integration method
    iv. Design of non-prismatic beams
g. Transformation of stress and strain
    i. Plane stress
        1. State of stress
        2. Mohr"s circle for plane stress and strain
        3. Transformation of stress and strain
    ii. Principle stresses
        1. Principle stresses in beams
    iii. Stresses in thin-walled pressure vessels
    iv. Three-dimensional analysis of stress
    v. Failure theories
    vi. Measurement and analysis of strain and Strain rosette
h. Deflection of beams
    i. Deformation under transverse loading
    ii. Statically indeterminate beams
    iii. Slope and deflection calculation by singularity functions
    iv. Slope and deflection calculation by integration
    v. Method of superposition for slope and deflection calculation
    vi. Moment area method for slope and deflection calculation
i. Columns
    i. Buckling of columns
    ii. Euler's formula and Secant for columns
    iii. Design of columns

Resources

Hibbler, Russel. *Mechanics of Materials*. 11th. Pearson Education, 2022.

Beer, Ferdinand., Johnston, Russell., Mazurek, David., Dewolf John. *Mechanics of Materials*. 8th. McGraw Hill, 2020.

Ugural, Ansel., Fenster Saul. *Advanced Mechanics of Materials and Applied Elasticity*. 6th ed. Pearson Education, 2019.

Resources Other

Engineering/scientific calculator

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