ENGR A240: MECHANICS OF MATERIALS

Item	Value
Curriculum Committee Approval Date	12/08/2021
Top Code	090100 - Engineering, General (requires Calculus) (Transfer)
Units	3 Total Units
Hours	54 Total Hours (Lecture Hours 54)
Total Outside of Class Hours	0
Course Credit Status	Credit: Degree Applicable (D)
Material Fee	No
Basic Skills	Not Basic Skills (N)
Repeatable	No
Grading Policy	Standard Letter (S), • Pass/No Pass (B)

Course Description

This course provides the engineering students with the means of analyzing and designing various structures and machines subjected to different loading conditions. Students develop the techniques of stress and strain analysis of the systems under axial, torsional, transverse loading and pure bending. It also includes the major topics of design of the beams, shafts and the columns. Analysis of systems using energy method, and deflection of beams by integration and moment-area methods are also introduced. PREREQUISITE: ENGR A280. Transfer Credit: CSU; UC. C-ID: ENGR 240.**C-ID:** ENGR 240.

Course Level Student Learning Outcome(s)

1. Upon completion of the course, the student will be able to analyze the structural system subjected to load or combination of loads and determine the applied load and the internal forces, torques and moments developed at a point or section.
2. Upon completion of the course, the student will be able to calculate the stresses, strains and displacements of the structural members such as axial members, shafts, beams and columns subjected to external loads.
3. Upon completion of the course, the student will be able to transform the stresses and strain using equations and Mohr's circle to determine the maximum shearing and principle stresses and strain to design the structural members.

Course Objectives

- 1. Use the stress-strain diagrams to determine the properties, derive and apply the generalized Hookes law.
- 2. Solve problems involving combination of axial members subjected to loads and/or change in temperature, and determine the stresses and dimensional changes.
- 3. Develop apply the torsional formula for the circular shaft and the angle of twist to analyze the shaft or combination of shafts, and design the shaft for power transmission.
- 4. Perform the transformation of stresses and strains at a point and draw Mohrs circle, and apply the concept to determine the stresses and strains and maximum values for design considerations.
- 5. Explain and apply the failure criteria to design the structural members and systems, determine the failure mode using the calculated stresses, strains and displacements.
- 6. Analyze the beam in bending due to moment in plane of bending, skewed load and eccentric axial loading, and determine the stress and strain distribution at a section.
- 7. Determine the horizontal and vertical shearing stresses and the distribution of stresses in beam.
- 8. Derive the equation of elastic curve and determine the deflection of beams using the method of section, singularity function and moment area methods.
- 9. Derive and apply the Eulers formulation to analyze the columns having different supports and design the columns for central and eccentric loads.
- 10. Derive the equations for and analyze the thin-walled vessels, shafts and beams.

Lecture Content

Review of Statics Equilibrium of rigid bodies Analysis of structures Factor of safety Area Moment of inertias Stress and Strain Axially Loaded Systems (Members) Types of loading Normal and shearing stresses Bearing stress, stress on oblique plane under axial loading Normal and shearing strains Tensile testing and normal stress-strain diagram Shearing stress-strain diagram Elasticity and plasticity, and Hookes law Mechanical properties and characteristics of materials using stress-strain curves. (Youngs modulus, Shear modulus, Poissons ratio, strain energy, yield strength, ultimate strength and rupture strength, Modulus of Resilience and toughness) Design of simple structures, working stress and factor of safety, creep and fatigue Dilatation and bulk modulus Plane stress and plane strain Generalized Hookes law for normal and shearing stresses strains Statically indeterminate structures Parallel and series combination of axial members with constant and/or varying forces/cross-section areas/materials Parallel and series combination of axial members with varying (continuous/discontinuous) internal forces/areas Displacement methods to determine the movement of specified point or points on the systems Stresses and strain in statically indeterminate structures during temperature change Stress concentrations: stress variations near holes and fillets Inelastic axial deformation using elastic-perfect plastic model Torsion Torsional deformation of circular shaft and angle of twist Torsional formula for circular solid and tubular shafts in elastic range Circular shaft with varying torque/cross-sectional area Statically indeterminate shafts Series and parallel combination of shafts in torsion with constant and/or varying forces/cross-section areas/materials Parallel and series combination of shafts in torsion with varying (continuous/discontinuous) internal forces/areas Displacement methods to determine the movement of specified point or points on the shaft Stress distribution and principal stresses in shafts Design for shaft for power transmission Stress concentrations in circular shafts at sudden change in cross-sectional area Plastic deformation in shafts and use of elastic-perfect plastic model and residual stresses Bending of Beam Deformation of straight beam in pure bending Normal stress and strain, transverse strain, curvature, and anti-elastic curvature Stress and deformation in elastic range and elastic flexure formula Stress distribution and strain distribution due to bending ont-size: small;"> Composite beams i.e. bending of beam made of two or more materials Un-symmetric bending analyzed as doubly symmetric beam Bending of members due to eccentric axial load in the plane of symmetry and combined load Elastic-perfect plastic model applied to beams in bending, residual stresses Bending of curved beams (optional) Shear and moment Diagrams, and design of Beams Drawing shear force and bending moments diagrams using the method of section Drawing shear force and bending moments diagrams using the singularity functions Design of prismatic beams for bending Deflection of Beams Deformation of a beam under transverse load and equation of elastic curve Equation of elastic curve using the load distribution Deflection and slope of beam using singularity functions Deflection and slope of beam using moment-area theorems Deflection and slope of beam subjected to combined load using the method of superposition Statically indeterminate beams (optional) Shearing Stresses in Beams Horizontal shear and shear flow Vertical shear stress and shear formula Distribution of shearing stress in beams Shearing stress in thin-walled beams and shear center Transformations of Stress and Strain General state of stress at a point State of plane stress and Transformation of plane stress Principal stresses and maximum shear stress Mohrs circle for plane stress General state of stress and principal stresses Transformation of plane strains and Mohrs Circle for plane strain Measurement of strains use rosette Stress distribution and principal stresses in beam Stresses and principal stresses in member of subjected to combined loads Pressure Vessels Stress in spherical and cylindrical pressure vessels Stress in spherical and cylindrical thin-walled pressure vessels Design of thin-walled pressure vessels Failure Criteria Maximum-Shearing-Stress Criterion ductile materials (Tresca Hexagon Criteria) Maximum-Distortion-Energy Criterion (Von Mises Criteria) Maximum-Normal-Stress Criterion (brittle materials) Mohrs Criterion (brittle materials) Columns Buckling and stability of columns Eulers formula for ideal column with pin supports Columns having different supports and modification of Eulers formula b Secant Formula for column with eccentric loading Design of column with centric load Design of column with eccentric load/combined load Combined Loads and Stresses Analysis of systems subjected to combined loads and stresses are included in the above topics and are mentioned again as following Stress distribution and principal stresses in beam Un-symmetric bending analyzed as doubly symmetric beam Bending of members due to eccentric axial load in the plane of symmetry and combined load Design of column with eccentric load/combined load Shear and moment diagram of beam subjected to combined loads Combination of axial members subjected to combined loads Combination of torsional shafts subjected to combined loads Design for shaft for power transmission Stresses and principal stresses in member of subjected to combined loads

Method(s) of Instruction

- Lecture (02)
- DE Live Online Lecture (02S)
- DE Online Lecture (02X)

Instructional Techniques

The primary mode of instruction is the lecture/demonstration method

Reading Assignments

Student will be assigned at least two hours per week worth of material form the textbook and articles.

Writing Assignments

Student will be assigned approximately at least two hours per week worth of writing assignments, including explanation and discussion of results and findings in light of the theory and the application related to problem solving, open-ended problems, and material research/design projects.

Out-of-class Assignments

Student will be assigned at least three hours per week worth of problem solving and open-ended problems and material research/design projects.

Demonstration of Critical Thinking

Solve open-ended problems involving systems subjected to combined loading and other related engineering concepts, and complete a design problem using the stress analysis techniques and the constraints.

Required Writing, Problem Solving, Skills Demonstration

Problem solving exercises, and open-ended problems assigned as homework assignments, and question on tests, examination and quizzes requiring documentation and written responses.

Eligible Disciplines

Engineering: Masters degree in any field of engineering OR bachelors degree in any of the above AND masters degree in mathematics, physics, computer science, chemistry, or geology OR the equivalent. (NOTE: A bachelors degree in any field of engineering with a professional engineers license is an alternative qualification for this discipline.) Masters degree required. Title 5, section 53410.1

Textbooks Resources

1. Required Beer Johnston and DeWolf Mazurek. Mechanics of Materials, 8th ed. McGrall Hill, 2020 2. Required Goodno and Gere. Mechanics of Materials, 9th ed. Cengage Learning, 2018 3. Required R. c. Hibbeler. Mechanics of Materials, 10th edition ed. .: Printice Hall, 2017