

ME 420
Strength of Materials
(4 credit hours)

Objectives

1. Obtain a thorough understanding of the fundamental concepts of internal force and deformation distributions in solid bodies (internal normal/shear forces, stress, strain, material behavior, stress-strain relations, stress and strain transformations, principle stress and strain, and statically indeterminate structures)
2. Apply these concepts to size structural elements and determine allowable loads on structures based on considerations of strength through critical values of stress and strain which have been observed to govern material failure
3. Develop a systematic approach to solving problems, including careful sketching, precise mathematical notation, clear presentation of solution, and computer generated plotting of results

Prerequisites

Any of the following courses or equivalent:
 ME H210, Honors Statics
 ME 410, Statics

Before taking this class, the students should specifically know:

1. Algebra and Trigonometry
2. Vectors (graphical representation, components, dot product, and cross product)
3. Calculus of a single variable
4. Statics (free body analysis, forces, couples, moments, equations of equilibrium, shear and bending moment diagrams, and area moments of inertia)

Topics

1. Stress and Strain
2. Allowable Loads and Factor of Safety
3. Material Behavior, Stress-Strain Relations, and Statically Indeterminate Problems
3. Axial, Torsional, and Bending and Pressure Loading Applications
5. Beam Deflections and Column Buckling
6. Computer Mini-Projects

Basis of Grading

1. Midterm
2. Final
3. Homework
4. Quizzes
5. Computer Projects

Stress and Strain

1. Definition of normal and shear stress as force intensities on an internal cross-section
2. Definition of normal strain as normalized stretch or compression
3. Definition of shear strain as angular distortion
4. Equations for transforming stress and strain between rotated cartesian coordinate systems (Mohr's Circle)
5. Principle (max/min) normal stress and strain and maximum shear stress and strain

Allowable Loads and Factor of Safety

1. Critical stress and strain
2. Allowable loads determined from a factor of safety
3. Average normal and shear stress on a cross-section
4. Design and sizing of connections (critical shear stress in pins and bearing stress)

Material Behavior, Stress-Strain Relations, and Statically Indeterminate Problems

1. Elastic and plastic deformation, typical stress-strain behavior of engineering materials
2. Hooke's Law (linear elastic stress-strain relation), Young's modulus, and Poisson's ratio
3. Determine reactions and internal stresses of statically indeterminate structures by accounting for both deformation conditions and equilibrium (applications to axial, thermal, torsion, and bending loading)

Axial, Torsional, and Bending and Pressure Loading Applications

1. Normal stress and strain distributions of axially loaded bars (deformation formula)
2. Shear stress and strain distribution of bars in torsion (angle of twist formula)
3. Normal bending and transverse shear stress distributions in laterally loaded beams
4. Normal (through thickness) stresses in pressure vessels
5. Principle stresses, design, and combined loading

Beam Deflections and Column Buckling

1. Obtain slope and deflection distributions in laterally loaded beams by integrating moment-curvature relations with boundary conditions
2. Determine critical (Euler) buckling loads of axially loaded columns with various end conditions by applying moment-curvature relations to the buckled shape

Computer Mini-Projects

Several parameter study and graphing exercises on the computer will be assigned