

# STRENGTH OF MATERIALS

ENME 205

**Lecture** : 3  
**Tutorial** : 1  
**Practical** : 1.5

**Year** : II  
**Part** : I

## Course Objectives:

The objective of this course is to analyze and solve problems related to various types of stress and strain, ensuring the safety of components or systems. Additionally, to design basic components of structure and machines on the basis of stiffness, strength and stability.

- 1 Introduction (2 hours)**
  - 1.1 Scope of strength of materials
  - 1.2 Types of stresses and strains (Normal, shear, bearing)
  - 1.3 Ultimate stress, allowable stress and factor of safety
  
- 2 Stress and Strain in Axial Loading (6 hours)**
  - 2.1 Stress-strain diagram
    - 2.1.1 For ductile and brittle material
    - 2.1.2 Comparison between engineering and true stress-strain diagram
  - 2.2 Hooke's' law, modulus of elasticity
  - 2.3 Deformation under axial load including self-load (In varying cross-section members, composite members)
  - 2.4 Temperature effects
  - 2.5 Multi-axial loading, generalized Hooke's law, Poisson's ratio
  - 2.6 Stress concentration and plastic deformation
  - 2.7 Statically indeterminate problems
  
- 3 Pure Bending (6 hours)**
  - 3.1 Introduction of pure or simple bending
  - 3.2 Deformation of a member in pure bending in elastic range (Relationship between transverse loads, bending moment and bending stresses, position of neutral axis)
  - 3.3 Moment of resistance, section modulus
  - 3.4 Beams with composite section
  - 3.5 Eccentric axial loading, unsymmetrical bending
  - 3.6 Stress concentration and plastic deformation

- 4 Torsion (6 hours)**
- 4.1 Introduction of shaft, torque, torsion
  - 4.2 Stress and strain in a uniform shaft in elastic range
  - 4.3 Torsion-moment diagram
  - 4.4 Torsional formula for circular cross-section shaft, power transmission by shaft
  - 4.5 Design of shaft (By strength and stiffness)
  - 4.6 Comparison between hollow and solid shaft
  - 4.7 Shafts in series and parallel, composite shafts
  - 4.8 Statically Indeterminate problems
  - 4.9 Stress concentration and plastic deformation
- 5 Transverse Loading (3 hours)**
- 5.1 Relationship between Shear force and shear stress in a beam
  - 5.2 Distribution of shear stress in different beam sections (Rectangular, circular, triangular, I and T type)
- 6 Transformation of Stress and Strain (6 hours)**
- 6.1 Uniaxial, biaxial stress system, pure shear stress system
  - 6.2 General plane system, principal planes, principal stresses, maximum shear stress
  - 6.3 Graphical method: Mohr's circle for plane stress
  - 6.4 Mohr's circle for plane strain
  - 6.5 Yield criteria for ductile and brittle material
- 7 Deflection of Beams by Analytical Method (6 hours)**
- 7.1 Deflection equation for beams with different end conditions under point, uniformly and distributed load by double integration method
  - 7.2 Method for superposition
  - 7.3 Macaulay's methods
  - 7.4 Deflection in statically indeterminate beams
- 8 Deflection of Beams by Moment-Area Method (4 hours)**
- 8.1 Moment-area theorems
  - 8.2 Application to symmetrical, unsymmetrical structures and symmetrical and unsymmetrical loading
- 9 Columns (3 hours)**
- 9.1 Strut, column, buckling load
  - 9.2 Euler's formula for different end conditions, effective length
  - 9.3 Design of column under central loading
  - 9.4 Design of column under eccentric loading

**10 Design of Beams and Shaft****(3 hours)**

- 10.1 Basic considerations for the design of prismatic beams (For ductile and brittle material and for short and long beam)
- 10.2 Design of prismatic beams

**Tutorial****(15 hours)**

1. Stress and strain in axial loading, bearing loading
2. Pure bending
3. Torsion
4. Transverse loading
5. Transformation of stress and strain
6. Deflection of beams by double integration method, Macaulay's method
7. Deflection of beams by moment-area method (Point load, UDL, and UVL)
8. Design of beams and shafts
9. Columns: Numerical on different end conditions using Euler's formula

**Practical****(22.5 hours)**

1. Tensile and compressive test of ductile and brittle materials (Ferrous metals)
2. Torsion test of shafts for brittle and ductile material (Cylindrical cross-section)
3. Relationship between buckling load and end conditions for struts
4. Relationship between deflection of simply supported beams and modulus of elasticity, moment of inertia
5. Relationship between deflection of cantilever beams and modulus of elasticity, moment of inertia

**Final Exam**

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1 and 2	8	8
3	6	8
4	6	8
5	3	4
6	6	9
7	6	9
8	4	6
9	3	4
10	3	4
<b>Total</b>	<b>45</b>	<b>60</b>

\* There may be minor deviation in marks distribution.

## References

1. Beer, F. P., Johnson, E. R. (2020). Mechanics of materials. McGraw Hill.
2. Rajput, R. K. (2015). Strength of materials. S. Chand & Co. Ltd.
3. Bansal, R. K. (2018). Strength of materials. McGraw Hill.
4. Popov, E. P. (1998). Engineering mechanics of solids. Prentice Hall Inc.
5. Motra, G. B. (2021). A textbook of strength of materials. Heritage Publishers & Distributors Pvt. Ltd.