ENGINEERING MECHANICS I

ENME 103

Lecture : 3 **Year : I**
Tutorial : 1 **Part : I**
Practical : 0

Course Objectives:
To provide the fundamental principles, concepts and application of mechanics for solving engineering problems. To become familiar with the analytical and graphical methods for solving problems of mechanics, mainly of statics.

1 Forces Acting on Particle (6 hours)

1.1 Introduction to mechanics
1.2 Scalars, vectors and vector operations
1.3 Definitions and concept of particle, deformable and rigid bodies
1.4 Fundamental concepts and principles of mechanics: Newtonian mechanics
1.5 Concept of particles and free body diagram
1.6 Equation of equilibrium in two dimension
1.7 Force in space

2 Forces Acting on Rigid Body (6 hours)

2.1 External and internal force
2.2 Principle of transmissibility and equivalent forces
2.3 Resolution of a force into forces and a couple
2.4 Resultant of force and moment for a system of force
2.5 Equilibrium of two force and three force body
2.6 Equation of equilibrium in three dimension

3 Center of Gravity and Centroids (6 hours)

3.1 Centre of gravity of two dimensional body
3.2 Centroid of areas and lines
3.3 First moment of area and lines
3.4 Determination of centroids by integration and theorems of Pappus-Guldinus
3.5 Centre of gravity of three dimensional body
3.6 Introduction to composite plate and wire

4 Moment of Inertia (7 hours)

- 4.1 Moment of inertia of area
  - 4.1.1 Second moment of area
  - 4.1.2 Polar moment of inertia
  - 4.1.3 Radius of gyration
  - 4.1.4 Parallel axis theorem for area moment of inertia
  - 4.1.5 Moment of inertia of composite areas
- 4.2 Mass moments of inertia
  - 4.2.1 Moment of inertia of a simple mass
  - 4.2.2 Parallel-axis theorem for mass moments of inertia
  - 4.2.3 Moments of inertia of thin plates
  - 4.2.4 Mass moment of inertia of composite bodies

5 Friction (6 hours)

- 5.1 Laws of friction
  - 5.1.1 Static and dynamic coefficient of friction
  - 5.1.2 Angle of friction
- 5.2 Application of friction in engineering
  - 5.2.1 Example as high tension friction
  - 5.2.2 Wedge and screw
  - 5.2.3 Belt friction
- 5.3 Friction on axles, disks, and wheels
  - 5.3.1 Journal bearings and axle friction
  - 5.3.2 Thrust bearings and disk friction
  - 5.3.3 Wheel friction and rolling resistance

6 Introduction to Structure: Beam and Frame (8 hours)

- 6.1 Reactions for a two-dimensional structure
  - 6.1.1 Rocker/roller support, short cable/link
  - 6.1.2 Hinge/rough surface, frictionless pin
  - 6.1.3 Fixed support
- 6.2 Types of loading and supports; Examples and standard symbols
  - 6.2.1 Point load
  - 6.2.2 Uniformly distributed load
  - 6.2.3 Uniformly varying load
- 6.3 Concept of statically/kinematically determinate and indeterminate beams and frames
- 6.4 Relation of load, axial force, shear force and bending moment
  - 6.4.1 Determinate beams
  - 6.4.2 Determinate frame
  - 6.4.3 Axial force, shear force and bending moment calculation and diagram

7 Analysis of Trusses (6 hours)

7.1 Concept of simple truss and pin joints/joint loads in trusses
7.2 Calculation of member forces of truss by method of joints
7.3 Calculation of member forces of truss by method of joints under special loading conditions
7.4 Calculation of member forces of truss by method of sections
7.5 Introductory concept of machines

Tutorials (15 hours)

1. Sample problems related to vector operations, free body diagram, equilibrium and force in space
2. Sample problems related to equivalent forces, resolution resultant of force & moment, and equilibrium of multiple force and equilibrium in 3D
3. Sample problems related to centroid of areas and lines, three dimensional body and composite body
4. Sample problems for determination of the moment of inertia of an area, mass and composite objects by various methods
5. Sample problems related to coefficient of friction, wedge, screw, belt, journal bearings, thrust bearings, axle, disk and wheel
6. Sample problems related to statically/kinematically determinate and indeterminate structure, load, axial force, shear force and bending moment and its diagram in beams and frames
7. Sample problems related to simple trusses using methods of joints and sections

Assignments

1. Tutorial submission
2. A case study of a real time problem
3. Project preparation and demonstration

Reference

1. Beer, F. P., Johnston, E. R. (2024). Vector mechanics for engineers: Statics and dynamics. McGraw-Hill Education.
2. Hibbeler, R.C. (2022). Engineering mechanics: Statics & dynamics. Pearson.
3. Meriam, J.L., Kraige, L.G. (2020). Engineering mechanics: Statics and dynamics. John Wiley & Sons.
4. Jong, I.C., Rogers, B.G. (1991). Engineering mechanics: Statics and dynamics (Latest Edition). Saunders College Publishing.
5. Sandor, B.I. (1983). Engineering mechanics: Statics and dynamics (Latest Edition). Prentice-Hall.
6. Parajuli, H. R., Neupane, S. (2022). A textbook of applied mechanics for engineers. Heritage Publishers and Distributors.