ENGINEERING MECHANICS

ENCE 154

Lecture : 4 **Year : I**
Tutorial : 2 **Part : II**
Practical : 0

Course Objectives:
This course helps to analyze the effect of various types of forces on the particle and rigid body at rest and motion. It also provides concept and knowledge of engineering application and helps to understand structural engineering in later courses by using basics of mechanics in their branch of engineering.

1 Basic Concept of Mechanics and Static Equilibrium (5 hours)

1.1 Definitions, type and scope of mechanics
1.2 Fundamental concepts and principles of engineering mechanics
1.3 Concept of particle, rigid and deformed bodies
1.4 Physical meaning of equilibrium and its essence in structural application
1.5 Equation of equilibrium in 2D and 3D analysis of particle and rigid body
1.6 Concept of free body diagram with examples

2 Forces Acting on Particle and Rigid Body (9 hours)

2.1 Different types of forces: Internal/external force, adhesive/ cohesive force, point/ line/ surface force and contact/ body force
2.2 Resolution and composition of forces
2.3 Principle of transmissibility and equivalent forces
2.4 Varignon's theorem and its application
2.5 Moments of a force about a point and about an axis
2.6 Definition, types and characteristics of couple
2.7 Resolution of a force into a force and a couple
2.8 Resultant of force and moment for a system: Coplanar, concurrent and general force system
2.9 Concept and formation of wrench (Force and couple lying on a single plane)

3 Friction (4 hours)

3.1 Definition, types and uses of friction, laws of friction, static and dynamic coefficient of friction, angle of friction
3.2 Sliding and overturning condition of a body
3.3 Concept and working principle of jackscrew
3.4 Practical examples of dry friction (Ladder and Wedge friction)

4 Analysis of Simple Beams and Frames (10 hours)

4.1 Introduction to structures
4.2 Various types of load on the structure
4.3 Various types of supports; Reactions and degree of freedom
4.4 Internal and external forces in the structure
4.5 Relationship between load, shear force and bending moment
4.6 Statically and geometrically stable/ unstable beams and frames
4.7 Statically determinate and indeterminate beams and frames, degree of static indeterminacy
4.8 Axial force, shear force and bending moment diagrams for determinate beams and frames

5 Analysis of Plane Trusses (5 hours)

5.1 Definition of truss, assumption of ideal truss, types and uses of truss in engineering
5.2 Statically and geometrically stable and unstable truss
5.3 Statically determinate and indeterminate truss, degree of static indeterminacy
5.4 Analysis of truss by the method of joint and section/ moment

6 Centre of Gravity, Centroid, Moment of Inertia, and Mass Moment of Inertia (5 hours)

6.1 Concepts of centre of gravity and centroid of line, area and volume
6.2 Second moment of area/moment of inertia and radius of gyration
6.3 Perpendicular and parallel axis theorem for moment of inertia
6.4 Concept of mass moment of inertia

7 Kinematics of Particles (Rectilinear and Curvilinear Motion) (7 hours)

7.1 Position, velocity and acceleration of a particle for rectilinear motion
7.2 Dependent and relative motion of particles
7.3 Position, velocity and acceleration of a particle for curvilinear motion
7.4 Projectile motion
7.5 Tangential and normal components of velocity and acceleration
7.6 Radial and transverse components of velocity and acceleration

8 Kinetics of Particles: Force, Acceleration, Energy and Momentum (8 hours)

8.1 Newton's second law of motion, linear momentum and impulsive motion
8.2 Equation of motion and dynamic equilibrium
8.3 Angular momentum and rate of change of angular momentum
8.4 Equation of motion for rectilinear and curvilinear motion (Rectangular components, tangential and normal components and radial and transverse components) of particle

8.5 Work and energy principle
8.6 Principle of conservation of energy, concept of conservative and non-conservative system
8.7 Definition and types of impact

9 Kinematics and Kinetics of Rigid Body in Plane Motion, Energy and Momentum Methods (7 hours)

9.1 Translation, rotation and general plane motion
9.2 Absolute and relative velocity in plane motion
9.3 Instantaneous centre of rotation
9.4 Equation of motion: D'Alembert's principle
9.5 Angular momentum of rigid body
9.6 Principle of work and energy for a rigid body
9.7 Kinetic energy for a rigid body

Tutorials (30 hours)

1. Basic concept of mechanics and static equilibrium
2. Forces acting on particle and rigid body
3. Friction
4. Analysis of simple beams and frames
5. Analysis of plane trusses
6. Centre of gravity, centroid, moment of inertia and mass moment of inertia
7. Kinematics of particles (Rectilinear and curvilinear motion)
8. Kinetics of particles: Force, acceleration, energy and momentum
9. Kinematics and kinetics of rigid body in plane motion, energy and momentum methods

Final Exam

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

Chapter	Hours	Mark distribution*
1	5	4
2	9	10
3	4	4
4	10	14
5	5	5
6	5	5
7	7	6
8	8	6
9	7	6
Total	**60**	**60**

* There may be minor deviation in marks distribution.

Reference

1. Beer, F. P., Johnston, E. R. (2019). Vector Mechanics for Engineers: Statics and Dynamics (12th ed.). McGraw-Hill Education.
2. Hibbeler, R. C., Gupta, A. (2024). Engineering Mechanics: Statics and Dynamics (14th ed.). Pearson.
3. Jong, I. C., Rogers, B. G. (1995). Engineering Mechanics: Statics and Dynamics. Oxford University Press.
4. Suwal, R. (2014). A textbook of applied mechanics (2nd ed.). Kathmandu, Nepal: Markline Publication.
5. Parajuli, H. R., Neupane, S. (2016). Applied mechanics for engineers (1st ed.). Kathmandu: M.K. Publishers & Distributors.
6. Parajuli, H. R., Neupane, S. (2022, September). A Textbook of Applied Mechanics — Dynamics II for Engineers (1st ed.). Heritage Publishers & Distributors Pvt. Ltd.
7. Dhital, M.R. (1999) A Course Manual on Applied Mechanics I (Statics)", TU, IOE, CIMDU.
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9. Shames, I. H. (1996). Engineering Mechanics: Statics and Dynamics (4th ed.). Prentice Hall of India.
10. Anand, D. K., Cunniff, P. F. (1973). Engineering mechanics: statics and dynamics. Houghton Mifflin.
11. Khurmi, R. S., Khurmi, N. (2019). A textbook of engineering mechanics (20th ed.). S. Chand Publishing.
12. Popov, E. P. (1990). Engineering mechanics of solids. Prentice Hall.