Marwadi University

Bachelor of Technology
Civil Engineering

01CI0301: Mechanics of Solids

Objective of the Course

Objectives of introducing this subject at second year level in civil branches are:

- To study about identification of different types of forces, systematic evaluation of effect of these forces, behavior of rigid bodies subjected to various types of forces, at the state of rest or motion of the particles, as Universe exist due to force only.
- To understand the fundamental principles, concepts and techniques, both theoretical and experimental, with emphasis on the application of these to the solution of mechanics based suitable problems in all engineering.
- To provide a firm foundation and formwork for more advanced study at every higher semester as the subject of Mechanics of Rigid bodies cuts broadly across all branches of engineering profession.

Credits Earned : 5

Students Learning Outcomes

After studying this subject students will be able to:

- On the completion of the course one should be able to understand:
- Students will able to understand the laws of mechanics and their application to engineering problem.
- Student will be able to understand the fundamentals of stress/strain analysis and be able to apply them with confidence to simple structure.
- Fundamental related to subject will facilitate students to design structures, predict failure and understand the physical properties of materials in higher semester.

Teaching and Examination Scheme

Subject Name	Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
	Theory	Tutorial	Practical		ESE (E)	Mid Sem (M)	Internal (I)	Viva (V)	Term Work (TW)	
Mechanics of Solids	3	1	2	5	60	30	10	25	25	150

Detailed Syllabus

Sr. No.	Topic Name	Hours
1	**Introduction**	**2**
	1.1 Terminologies: space, time, particle, rigid body, deformable body. Force: Definition, categorization of forces, Characteristics of a force, System of forces and resolution of forces.	
	1.2 Principles of mechanics: Principles of Transmissibility, superposition, Gravitational Law and Parallelogram Law of Forces.	

Sr. No.	Topic Name	Hours
2	**Fundamentals of Statics**	8
	2.1 Force and Force system: System of Forces its definition and application in Engineering.	
	2.2 Coplanar concurrent force system: Derivation of resultant force and equilibrant force using analytical and graphical methods. Triangle law of forces and Polygon law of forces.	
	2.3 Equilibrium of rigid bodies: Conditions of equilibrium, Lami's theorem and its derivation. Concept of Free body diagram in engineering. Application of Lami's theorem in various problems.	
	2.4 Coplanar non-concurrent forces: Definition of moment, couple and its effect on rigid bodies. Properties of couple, equivalent force couple system with examples, Varignon's theorem and its derivation.	
	2.5 Resultant of Coplanar non-concurrent Force system: Calculation of resultant force in coplanar non-concurrent force system by analytical and graphical methods.	
3	**Analysis of Determinate Beams**	8
	3.1 Classification of loads, supports and beams	
	3.2 Support Reactions: Calculation of support reactions for determinate beams subjected different loads viz. (i) Concentrated loads and moment, (ii) Uniformly distributed load, and (iii) Uniformly Varying loads.	
	3.3 Internal forces in beams: Definition of shear force and bending moment. Correlation between loading, shear force & bending moment in beams.	
	3.4 Shear Force and Bending Moment Diagrams: Bending moment and shear force diagrams for beams subjected to; i) Concentrated loads and moment, (ii) Uniformly distributed load, and (iii) Uniformly Varying loads. Point of Contra flexure and maximum bending moment in a beam.	
4	**Concepts and Application of Static Friction**	6
	4.1 Introduction: Theory, Classification and laws of Static and Dynamic friction.	
	4.2 Glossary of Terms: Angle of friction, Coefficient of friction, Angle of repose and Cone of friction.	
	4.3 Application **of Static Friction -** **(a) Block friction**: Solutions of problems involving block friction in horizontal and inclined planes.	
	(b) Ladder **Friction:** Solution of various problems.	
	(c) Wedge**, Belt and Rope Friction**: Solution of various problems.	

Sr. No.	Topic Name	Hours
5	**Centroid and Moment of Inertia**	**9**
	5.1 Centroid: Definition, concept, and evaluation of centroid for one-dimensional standard geometry viz. horizontal, vertical, inclined and circular curved lines.	
	5.2 Centroid of Standard Geometrical shapes: Determination of centroid for standard two-dimensional and three-dimensional shapes viz. rectangular, triangular, circular, semi-circular, quarter circular, circular segments, cylindrical, conical, spherical and cubical shapes.	
	5.3 Calculation of Centroid: Calculation of centroid for composite lines, areas and volumes.	
	5.4 Pappus-Guldinas Theorem: Pappus Guldinus theorem and its application in calculating surface area and volume.	
	5.5 Introduction to Moment of Inertia: Definition and concept of Moment of Inertia. Perpendicular axis, Parallel axis theorem, Polar Moment of inertia, and radius of gyration.	
	5.6 Moment of Inertia for Planar cross-sections: Determination of Moment of Inertia for **planar** sections using parallel axis theorem for standard lamina.	
	5.7 Moment of Inertia for composite planar elements: Determination of **moment** of Inertia for composite lamina.	
6	**Simple Stresses & Strains**	**10**
	6.1 Introduction: Definition and types of simple stresses (direct and indirect) and strains (linear and lateral) in an element and its importance in **engineering**.	
	6.2 Relation between stress and strain: Hooke's law, Poisson's ratio, Modulus of Elasticity, Rigidity, and Bulk modulus.	
	6.3 Stresses and strains Members: Evaluation of stresses and strains in members **subjected** to axial and shear loading for homogenous, composite, prismatic and tapered sections.	
	6.4 Thermal Stresses: Evaluation of stresses in elements subjected to temperature effects **in** homogeneous and composite members	
	6.5 Inter-relationship between various Moduli: Relationship between modulus of **elasticity**, rigidity, bulk modulus and Poisson's ratio with problems.	
	6.6 Multidirectional Stresses: Volumetric strains, effect of multi-directional **stresses** on homogeneous members.	
7	**Stresses in Beams**	**6**
	7.1 Theory of Pure Bending – Assumption, theory and derivation of equation for pure bending. Determination of bending stresses at various sections.	
	7.2 Flexural stresses – Section modulus and determination of flexural stress distribution in beams of various cross sections.	
	7.3 Equation of Shearing stress – Derivation of equation for shear stress across the **cross** section in a beam.	
	7.4 Shear stresses – Qualitative and Quantitative determination of shear stress distribution **in** beams having various cross sections.	

Sr. No.	Topic Name	Hours
8	**Torsion**	**3**
	8.1 Equation of Pure Torsion: Definition of Torsion, Assumption and derivation of equation for pure torsion in circular shafts, Torsional rigidity and its **application**.	
	8.2 Stresses due to Torsion: Torque generated due to Power transmitted in shaft. Stresses generated in members subjected to circulatory motion in circular and hollow circular shafts.	
9	**Principle Stresses**	**4**
	9.1 Introduction: Two-dimensional stress system. Evaluation of stresses in an inclined **plane** for members subjected to orthogonal stresses. Definition of principal plane, principal stresses, angle of obliquity, and resultant stress.	
	9.2 Principal Stress and Strain: Evaluation of Principal plane and principal stresses using **analytical** method.	
	9.3 Analysis of Principal **stresses** and principal planes for two-dimensional stress system.	
	9.4 Application of **Mohr's** circle and ellipse of stress.	
Total		**56**

List of Practicals

1. Find out resultant of concurrent forces.
2. Find out resultant of non concurrent forces.
3. Demonstrate and prove lami's theorem.
4. Find out beam reactions.
5. Find out mechanical properties of material.
6. Design a stable object.
7. Using popsicle sticks or straw prepare model of tower to carryout highest load for given dimensions.

Suggested Theory Distribution

The suggested theory distribution as per Bloom's taxonomy is as per follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyze	Evaluate	Create
5%	30%	40%	15%	10%	00%

Instructional Method and Pedagogy

1. At the start of course, the course delivery pattern, prerequisite of the subject will be discussed.
2. Lectures will be also conducted with the aid of multi-media projector, black board, OHP etc.
3. Attendance is compulsory in lectures and laboratory which carries a 5% component of the overall evaluation.
4. Minimum two internal exams will be conducted and average of two will be considered as a part of 15% overall evaluation.
5. Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regular interval. It carries a weightage of 5%.
6. Surprise tests will be conducted which carries 5% of the overall evaluation.
7. The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.
8. Minimum 8 experiments shall be there in the laboratory related to course contents.
9. Minimum 6 tutorials which includes solution of minimum 5 numerical under each head.

Recommended Study Material

Text Books:

Applied Mechanics S. B. Junarkar & H. J. Shah-Charotar Publication

Reference Books:

1. Engineering Mechanics by G. S. Sawhney; PHI New Delhi
2. Mechanics of Materials: Beer and Johnston, TMH
3. Mechanics of Materials: Gere & Timoshenko; CBS Publishers & Distributors, Delhi
4. Mechanics of Materials: Hibbler R C; Pearson Education
5. Strength of materials; Ramamutthram
6. Engineering Mechanics of Solids: Popov E.P; Prentice Hall of India, New Delhi