Marwadi University

Bachelor of Technology

Civil Engineering

Mechanics of Solids

01CI1301

Objective of the Course:

- 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.

Credit Earned: 05

Students learning outcomes:

After successful completion of the course, it is expected that student will be able to,

1. Apply fundamental principles of mechanics to get responses of rigid and deformable bodies.
2. Determine Center of Gravity and moment of inertia of simple and complex geometrical Shapes.
3. Describe the mechanical behavior of engineering materials subjected to various types of stresses and strain.
4. Analyze the determinate beam and draw its shear force and bending moment diagram.

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	IA (M)	CSE (I)	Viva (V)	Term Work (TW)	
04	00	02	05	50	30	20	25	25	150

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Detailed Syllabus

Sr No.	Title of the unit	Number of hours
1	**Fundamentals of Statics**	15
	Introduction: Definitions of Space, time, particle, rigid body, deformable-body, Force, Characteristics of a force, System of forces, Application of force in engineering and resolution of forces, Principles of Transmissibility, superposition, Gravitational Law and Parallelogram Law of Forces. **Coplanar concurrent force system:** Derivation of the resultant force and equilibrant force using analytical and graphical methods. Triangle law of forces and Polygon law of forces. **Equilibrium of rigid bodies:** Conditions of equilibrium, Lami's theorem, Concept of Free body diagram in engineering. Application of Lami's theorem in various problems. **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. **Resultant of Coplanar non-concurrent Force system:** Calculation of resultant force in coplanar non-concurrent force system by analytical and graphical methods. **Support Reactions:** Types of beams, loads and supports, Calculation of support reactions for determinate beams subjected different loads.	
2	**Centroid and Moment of Inertia**	12
	Centroid: Definition, concept, and evaluation of centroid for standard one-dimensional, two-dimensional and three-dimensional shapes, centroid for composite lines, areas and volumes. **Pappus-Guldinas Theorem:** Pappus Guldinus theorem and its application in calculating surface area and volume. **Moment of Inertia**: Definition and concept of Moment of Inertia. Perpendicular axis, Parallel axis theorem, Polar Moment of inertia, and radius of gyration. Moment of Inertia for planar sections using parallel axis theorem for standard lamina. Determination of moment of Inertia for composite lamina.	
3	**Stresses & Strains**	22
	Introduction: Definition and types of simple stresses (direct and indirect) and strains (linear and lateral) in an element and its importance in engineering, Hooke's law, Evaluation of stresses and strains in members **subjected** to axial and shear loading for homogenous, composite, prismatic and tapered sections. **Elastic Constants:** Poisson's ratio, Modulus of Elasticity, Rigidity, and Bulk modulus. Relationship between modulus of elasticity, rigidity, bulk modulus and Poisson's ratio with problems. Volumetric strains, the effect of multi-directional stresses on homogeneous members. **Thermal Stresses:** Evaluation of stresses in elements subjected to temperature effects in homogeneous and composite members	

	Bending Stress – Assumption, theory and derivation of equation for pure bending. Determination of bending stresses at various sections. Section modulus and bending stress distribution in beams of various cross-sections. **Shear stress** – Derivation of equation for shear stress across the cross-section, Qualitative and Quantitative determination of shear stress distribution in beams having various cross-sections. **Principle Stresses -** 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. Evaluation of Principal plane and principal stresses using analytical method. Analysis of Principal stresses and principal planes for two-dimensional stress system. Application of Mohr's circle and ellipse of stress. **Direct and Bending Stress**: Middle third rule, a kernel of a section and no-tension condition, Members subjected to direct and bending stresses, its examples and calculations of stresses, Stresses in the base of retaining walls and Dams due to water and soil-filled up to the top surface of the walls.	
4	**Torsion**	**04**
	Definition of Torsion, Assumption, and derivation of equation for pure torsion in circular shafts, Torsional rigidity, and its application. Torque generated due to Power transmitted in the shaft. Stresses generated in members subjected to circulatory motion in circular and hollow circular shafts.	
5	**Thin Cylinder**	**03**
	Circumferential and longitudinal stresses and strain in Thin cylinders and spherical vessels	
	Total	**56**

List of Practical

1) Law of Parallelogram of Forces
2) Coplanar Concurrent Forces
3) Coplanar Non-Concurrent Forces
4) Centroid and Center of Gravity
5) Differential Wheel and Axle
6) Double Purchase Crab
7) Compressive Strength
8) Tensile Strength
9) Hardness Test
10) Izod Impact Test

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 an effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyze	Evaluate	Create
10%	10%	35%	25%	10%	10%

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 taken in class room with the use of multi-media presentations, white board– mix of both.
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/Quizzes will be conducted which carries 5% component 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. Minimum 8 experiments are planned based on the course content.

Recommended Study Material

1. Mechanics of Materials: Beer and Johnston, TMH
2. Vector Mechanics for Engineers: Statics: Beer and Johnston, TMH
3. Mechanics of Materials: Hibbler R C; Pearson Education
4. Engineering Mechanics by G. S. Sawhney; PHI New Delhi
5. Mechanics of Materials: Gere & Timoshenko; CBS Publishers & Distributors, Delhi
6. Mechanics of Structures Vol-1, H. J. Shah, S. B. Junnarkar, Charotar publication.
7. Applied Mechanics S. B. Junarkar & H. J. Shah-Charotar Publication
8. Strength of Materials, R. S. Khurmi, S. Chand Publication.
9. Strength of Materials, R. K. Rajput, S. Chand Publication
10. Elements of Mechanics of Solids; M. N. Patel, P. V. Patel, C. S. Sanghavi & J. S. Thakur, Mahajan Publication.
11. Mechanics of solids; Santosh Shah & Siddharth Shah, Superior Publication.
12. Mechanics of solids; N. K. Arora, Book India Publication.