GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Civil Engineering

Course / Subject Code : DI03006041

Course / Subject Name : Mechanics of Structures-I

w. e. f. Academic Year:	2024-25
Semester:	3rd
Category of the Course:	PCC

Prerequisite:	Engineering Mechanics.
Rationale:	After learning Mechanics of rigid bodies in the 2nd semester as a course Engineering Mechanics, Mechanics of Structures-I is introduced in 3rd semester which mainly deals with analysis of deformable structures. The primary purpose of the study of this course is to understand the behaviour of various structural elements like beams, columns and truss members (struts/ties) under direct and transverse loads. Study of slope and deflection of beams will give insight to students about 'Stiffness', a very important property of the structure. This course enables the student to analyse the determinate structure and this will be helpful for safe and economical design of Steel & Concrete Structures used in Civil Engineering construction.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Analyse structural behaviour of various materials under axial loading.	R,U,A
02	Determine moment of inertia of a symmetrical and asymmetrical section about a given axis.	R,U,A
03	Draw and Interpret shear force and bending moment diagrams and determine the bending and shear stresses in beams for various types and loading conditions.	R,U,A
04	Determine slope and deflection in cantilever and simply supported beams.	R,U,A
05	Determine axial forces in the members of simple truss.	R,U,A
06	Analyse the column for axial load with various end conditions.	R,U,A

**Revised Bloom's Taxonomy (RBT)*

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Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA (M)	PA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Direct Stress & Strain** 1.1 Direct stress, Linear strain, Elasticity, Elastic limit, Hook's law, Modulus of Elasticity or Young's modulus, Stress Strain curve for mild steel bar under tension with numerical problems. 1.2 Lateral stress and strain, Poisson's ratio, Volumetric strain, Bulk modulus, relation between three moduli and numericals. 1.3 Basics Concepts of Shear Stress , Shear Strain & Modulus of rigidity. 1.4 Concept of composite and compound section, modular ratio and numericals. 1.5 Concept of Thermal stress and strain, Thermal stresses for non-yielding and yielding condition with numericals. 1.6 Stresses due to gradual, sudden and impact load, corresponding deformation, Strain energy, Resilience, Proof resilience and Modulus of resilience with numericals.	10	20
2.	**Moment of Inertia** 2.1. Importance of Moment of Inertia. 2.2. Axis of symmetry, Centroidal axis and axis of reference. 2.3. Parallel Axis Theorem & Perpendicular Axis Theorem 2.4. Formulas to calculate Moment of Inertia of solid and hollow rectangle, square, circle, triangle shapes (without derivations). 2.5. Moment of Inertia of symmetrical and asymmetrical I-section, Channel section, T-section, Angle section, Hollow sections and Built up sections about Centroidal axis and any other reference axis using Parallel axis theorem. 2.6. Polar Moment of Inertia of solid & hollow circular sections.	05	10
3.	**S.F. & B. M. in Beam**	10	20

	3.1 Statically Determinate and statically indeterminate beam examples. 3.2 Concept of Bending Moment and Shear Force in beam. 3.3 Sagging and Hogging Bending Moment. Positive and Negative Shear Force. 3.4 Calculation of Bending Moment and Shear Force at various sections of cantilever, simply supported and overhang beam subjected to point load and/ or u.d.l. 3.5 S.F. & B.M. Diagram for above beams 3.6 Point of Contra-flexure & its importance.		
4.	**Bending & Shear Stress in Beam** 4.1 Concept and theory of pure bending, assumptions, Bending equation (without derivation), Section Modulus, Bending stresses and their nature, Bending stress distribution diagram. 4.2 Concept of moment of resistance and simple numerical problems using bending equation. 4.3 Shear stress equation (without derivation), relation between maximum and average Shear stress for rectangular and circular section. 4.4 Shear stress distribution for square, rectangular, circle, hollow square, rectangular, circular, angle sections, channel section, I-section, T section. Simple numerical problems based on Shear equation.	06	15
5.	**Slope and Deflection** 5.1 Concept of Slope & Deflection of beams. 5.2 Flexural rigidity and its significance. 5.3 Formulas (without derivation) of maximum slope & deflection for cantilever beams subjected to point load at free end and u.d.l. Over the entire span. 5.4 Formulas (without derivation) of maximum slope & deflection for simply supported beams subjected to point load at center and u.d.l. over the entire span.	04	10
6.	**Analysis of Truss** 6.1 Type of truss - Simple, fink, compound fink, Howe truss, Pratt truss, North light truss, king post truss, queen post truss, French truss. Compare the simple truss with the beam. 6.2 Perfect, deficient and redundant truss. 6.3 Analysis of different trusses to find out axial forces in members using analytical method (method of joint) and graphical method.	06	15
7.	**Column & Strut**	04	10

	7.1 Column and Strut, radius of gyration, slenderness ratio, Short Column and Long Column. 7.2 End conditions & effective length of column. Mode of failure in column. 7.3 The limitations of Euler's theory for short column, Euler's formula for crippling load of long columns and numericals. 7.4 Rankin's formula for buckling load of short & long columns and numericals.		
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**30**	**50**	**-**	**-**	**-**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Eval6uate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

Sr. No.	**Title of Book**	**Author**	**Publication with place, year and ISBN**
1	Mechanics of Structures (Vol.-I)	Dr. H.J. Shah & S.B. Junnarkar	Charotar Publication, Anand. (2016)
2	Strength of Materials (Mechanics of Solids)	R.S.Khurmi N. Khurmi	S Chand Publishing, Delhi (2019) ISBN: 97-893-528-339-79
3	Strength of Materials	Dr. R.K.Bansal	Laxmi Publications(P) Ltd. New Delhi(2005) ISBN: 97-881-700-814-70
4	Strength of Materials	S. Ramamrutham & R.Narayanan	Dhanpat Rai Publishing Company (2011) ISBN:97-881-874-335-45
5	Theory of Structures	R.S.Khurmi	S Chand Publishing, Delhi (2000) ISBN: 97-881-219-052-06

(b) Open source software and website:

1) https://nptel.ac.in/courses/105104160 (NPTEL Course :- Mechanics of Solids by IIT, Kanpur)
2) https://nptel.ac.in/courses/105/105/105105108/ (NPTEL Course :- Strength of Materials by IIT, Kharagpur
3) www.vlab.co.in (Virtual Lab by Ministry of Education, Government of India)

Suggested Course Practical List:

Sr. No.	Practicals	Unit No.	Approx. Hrs. required
1	Conduct tension test on a given sample of mild steel and draw stress-strain curve.	1	04
2	Determine Young's Modulus of wire of given material.	1	02
3	Find out Compressive Strength of Cast Iron, Mild Steel, Wooden specimen with parallel & perpendicular to grains & Concrete cube.	1	04
4	Determine Izod impact value and Charpy impact value of given materials.	1	04
5	Compute Polar Moment of Inertia of Fly Wheel.	2	02
6	Conduct flexural test on wooden beam and find out ultimate bending stress.	3,4	02
7	Conduct shear test (Single and Double shear) on mild steel and cast iron specimen.	3,4	02
8	Find out deflection of cantilever beam for end point load and simply supported beam for central point load	5	04
9	Analyse at least two simple trusses using analytical method (method of joints) and verify with graphical method.	6	04
10	Demonstrate End Conditions of Column.	7	02
	Total hours		**30 Hrs.**

List of Laboratory/Learning Resources Required:

Sr. No.	Equipment Name with Broad Specifications	Practical No.
1	Universal Testing Machine with beam and shear attachment.	1,6 &7
2	Searl's apparatus to find Young's modulus of wire	2
3	Compression Testing Machine.	3
4	Izod & Charpy Impact Test Apparatus	4
5	Fly Wheel for polar moment of inertia	5
7	Deflection of beam apparatus	8

Sr. No.	Equipment Name with Broad Specifications	Practical No.
8	Working Model of End conditions of column	10

Suggested Project List:

a) Prepare spreadsheet or computer program to calculate the stresses in the composite section.
b) Compare tensile strength and cost of three locally available structural steel bars.
c) Compare modulus of elasticity of wires of three different materials using Searle's apparatus.
d) Prepare spreadsheet or computer program to calculate the support reactions of statically determinate beams.
e) Prepare spreadsheet or computer program to calculate the bending stress and shear stress in a beam having a rectangular or circular section.
f) Analyse statically determinate beam using freeware software.
g) Prepare spreadsheet or computer program to calculate slope and deflection of simply supported beam and cantilever beam for various load cases.
h) Calculate modulus of elasticity of a material by measuring deflection of beam.
i) Using drafting software, analyse the truss graphically.
j) Analyse the truss using freeware software.
k) Prepare spreadsheet or computer program to calculate safe load on column using Euler's and Rankine's formula.

Suggested Activities for Students: If any

a) Collect different situations with photographs of a structural members where axial force is predominant.
b) Collect the photographs of steel structural elements made of I-section, angle section, channel section and built-up section.
c) Collect different situations with photographs of a structural members where bending moment and shear force are predominant
d) Collect the photographs of five different types of truss in the field.
e) Collect the information with photographs of structural failure due to excessive axial load.
f) Collect the information with photographs of structural failure due to excessive bending moment
g) Collect the information with photographs of structural members having excessive deflection (beyond permissible limit)
h) Collect the information with photographs of failure of columns due to earthquake.

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