GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Civil Engineering

Subject Code: BE03006011

Subject Name: Theory of Structures

w. e. f. Academic Year:	2024-25
Semester/Year	3
Category of the Course:	Professional Core Course

Prerequisite:	Mechanics of Solids
Rationale:	This subject is conceptual applications of principles of mechanics of rigid and deformable bodies in Engineering. This subject helps in determining response of statically determinate framed structures. In addition to this, the topics related to stability checks for structure subjected to lateral loads, buckling behavior will also help the students in developing the basic concepts of structural analysis. Considering the important of computer analysis, use of professional software in structural analysis is a also kept in the syllabus.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
CO-1	Comprehend basic principles of structural analysis including equilibrium equations, Static & Kinematic Indeterminacy and stability of structure.	BL2
CO-2	Compute response of the structure in a statically determinate structures subjected to gravity & lateral loads.	BL3
CO-3	Differentiate the buckling behavior of columns & struts subjected to different end conditions.	BL4
CO-4	Identify load positions for worst effect of different structural responses in Statically determinate beams & trusses subjected to moving load.	BL4
CO-5	Perform computer analysis of statically determinate structure using professional software	BL3

Revised Bloom's Taxonomy (RBT)

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	**T**	**P**	**PBL***	**TH**		**ESE (E)**	**PA (M)**	**PA/ (I)**	**PBL (I)**	**ESE (V)**	
45	0	30	45	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.

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Course Content:

Sr. No.	Name of Topic	Teaching Hours	% Weightage
	MODULE 1		
1	**Unit-1 : Fundamentals of Statically Determinate Structures:** **Basics:** Types of statically determinate & indeterminate structures, static and kinematic indeterminacy, stability of structures, principle of superposition, Maxwell's reciprocal theorems. **Framed Structures:** Computation of internal forces in statically determinate framed structures such as plane truss, plane frame, grids, **Arches and Cables:** Calculation internal forces in three hinge arches with circular and parabolic shapes subjected to various types of loading. Forces and end actions in cables due to various types of loading. **Thin cylinder:** Analysis of thin cylinder and spherical vessels under pressure.	12	30
2	**Unit-2 : Statically Determinate structures** **(A) Strain Energy :** Resilience, strain energy due to axial loads, proof resilience, modulus of resilience, impact loads, and sudden loads	02	2525
	(B) Displacement of Determinate Beams : Differential equation of elastic curve, relation between moment, slope and deflection, Displacement of beam by Macaulay's method, Moment Area Method, Conjugate Beam Method	08	
3	**Unit-3 : Combined Stresses + Column & Struts** **(A) Principal stresses** Two-dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress, ellipse of stress and their applications **(B) Direct and Bending stresses** Members subjected to eccentric loads, middle third rule, kernel of section, Applications of Direct & Bending stresses: (1) chimney subjected to wind pressure, (2) Retaining walls subjected to earth pressure and (3) Dams subjected to		30

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	hydraulic pressure. **(C) Columns and Struts** Basics: Buckling of columns, different end conditions, effective length, least radius of gyration, Applications: Euler's and Rankine's formulae, columns with initial curvature, eccentrically loaded columns, columns with lateral loading.		
4	**Unit-4 : Statically determinate Structure subjected to Moving loads** Influence line diagrams ILD for statically determinate beams- I.L.D of support reaction, shear force and moment bending moment for beams subjected to u.d.l and several point loads, criteria for maximum effects, ILD for statically determinate trusses, forces in members for u.d.l and point loads	08	15
5	**Unit-5: Computer Applications in Structural Engg. (for Laboratory only)** Use of professional software such as STAAD-Pro/SAP/ETABS etc. for determining response of frames structure of the topics related to this course Create Modelling, Apply properties, boundary conditions, loading, perform analysis, post processing tools.	This portion to be covered in Laboratory	Theory Weightage shall be 0%

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	**20**	**30**	**20**	**10**	**10**

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

References/Suggested Learning Resources:
(a) Books:

1. Junarkar S.B. & Shah H.J.; Mechanics of Structures Vol-I; Charotar publishing house, Anand

2. Wang C. K.; Intermediate Structural Analysis; Tata McGraw Hill book Company, New Delhi

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3. Popov E.P.; Engineering Mechanics of Solids; Prentice Hall of India, New Delhi

4. Ryder G.H.; Strength of Materials; Mcmillan

5. Gere & Timoshenko; Mechanics of Materials; CBS Publishers & Distributors, Delhi

6. Hibbler R C; Mechanics of Materials; Pearson Education

7. Hibbler R C; Structural Analysis; Pearson Education

(b) Open source software and website:

1. http://nptel.ac.in/

Suggested Course Practical/Assignment List:

The students will have to solve at least five examples and related theory from each topic as an assignment/tutorial. Students will have to perform following experiments in laboratory and prepare the laboratory manual.

1. To verify Principle of Superposition & Maxwell Reciprocal theorm.
2. Determine displacement in Cantilever beam and/or Simply supported beam & verify with analytical method.
3. Determine displacement in statically determinate truss/frame & verify with analytical method.
4. Compute reactions in three hinge arch subjected to different loading.
5. Study behavior of axially loaded column with different end conditions.
6. Perform computer analysis of statically determinate beam & verify with analytical method.
7. Perform computer analysis of statically determinate truss/frame & verify with analytical method.

List of Laboratory/Learning Resources Required:

1. Structural Engg. Frame with models of beam, truss, frame for measurement of reactions, displacement etc.
2. Three hinge arch assembly.
3. Model of Axially loaded column with different end conditions
4. Professional software such as STAAD-Pro/ETAB/SAP

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- **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry visit –Construction Industry, cement industry, ceramic industry, tile industry and steel industry etc. related to Civil Engg.	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to topics of the course & new/emerging technology.	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numerical based assignment related to topics of the course	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using any programming language or application of software related to civil engineering	5 small coding-based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self learning on-line courses related to structural analysis, concrete technology , Building construction and BIM	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving related to building construction, leakage problem and concreting in water etc	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on safety aspects of workers working at construction sites and safety aspects of equipment used for high rise building construction and concreting.	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research papers related to civil structures, BIM and facilities etc.	4 hours per research paper. Maximum 15 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point presentation on topics such as Rain water harvesting, fire fighting systems etc. in high rise buildings, sustainable structures, earthquake resistant buildings etc.	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on	Working = 10 h	Based on inter

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	technical topics related to building construction and civil engineering structures	Non- working = 8 h	department/external evaluation
11.	Group Discussion on emerging/trending technical topics related to civil engineering structures, different types of concretes and buildings	Duration = 02 h each	Based on performance in group discussion, technical depth, knowledge etc.
12.	Real world case studies-based learning for state-of-the-art/new technology in building construction	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
13.	Use of Professional software for structural analysis, Building information management, Concrete mix designs etc.	Duration = 10 h	Depending on the complexity of the Application/Software
14.	Studies/surveys on requirements related to services in building like water supply, drainage, solar power and other facilities	Duration = 10 h	Based on in-depth study, data collected, fact finding and suggestions etc.
15.	Workshop/seminar attended related to civil engineering	Duration = 4 hrs per Workshop and 2 hrs per seminar attended. Maximum 10 hrs	Based on report submitted of summary and outcome of workshop/seminar attended

Note:
- All the suggested activity should be related to the subject.
- The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- For a course, minimum 3 to 4 activities shall be conducted. There is no limit for maximum number of activities; however any activity shall not be more than 10 hrs.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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