Techno India NJR Institute of Technology

Course File

Strength of Material (4CE4- 05)

For Techno India NJR Institute of Technology
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SYLLABUS

II Year-IV Semester: B.Tech. (Civil Engineering)

4CE4-05: STRENGTH OF MATERIALS

Credit: 3 **Max. Marks: 150 (IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hrs.
1	**Introduction:** to objective, scope and outcome of the subject	1
2	**Simple Stresses and Strains in different members:** Stresses in prismatic & non prismatic members and in composite members; Thermal stresses; Stresses in composite members, Compatibility condition.	5
3	**Compound Stress:** Two dimensional stress system: stress resultant, principal planes and principal stresses, state of pure shear maximum shear stress, Mohr's circle &its application. Introduction to theories of failures.	6
4	**Bending of Beams:** Bending moment, Shear force and Axial thrust diagrams for statically determinate beams subjected to various types of loads and moments, Point of Contra-flexure, relation between load, SF and BM.	8
5	**Theory of simple bending**: Distribution of bending and shear stresses for simple and composite sections, Combined direct and bending stress,	6
6	**Torsion:** Elementary concepts of torsion, shear stress in solid and hollow circular shafts, angle of twist, power transmitted by a shaft, combined bending and torsion;	4
7	**Columns:**Short and long columns, slenderness ratio, crushing and buckling of column, short column subjected to axial and eccentric loads; Euler's theory and its limitation, concept of effective length of columns; Rankine & Secant formulae, middle third rule, core of a section.	5
8	**Deflection of Beams:** Differential relation between load, shear force, bending moment, slope deflection. Slope & deflection in determinate beams using double integration method, Macaulay's method, area moment method and conjugate beam method and their application to statically determinate prismatic beams.	7
	TOTAL	42

Office of Dean Academic Affairs
Rajasthan Technical University, Kota

Course Overview:

Strength of Materials (also known as *Mechanics of Materials*) is the study of the internal effect of external forces applied to structural member. Stress, strain, deformation deflection, torsion, flexure, shear diagram, and moment diagram are some of the topics covered by this subject. The knowledge of this subject is a must in Civil Engineering, Mechanical Engineering, The main part in this subject is

- Focuses on the strength of materials and structural components subjected to different types of force and thermal loadings.
- Investigates materials subjected to different types of force and thermal loadings
- Emphasizes actual operating conditions.

Course Outcomes:

CO. NO.	Cognitive Level	Course Outcome
1	Design	Analyze and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.
2	Application	Execute the use of appropriate materials in design considering engineering properties, sustainability, cost and weight.
3	Application	Implement the skills for engineering work in accordance with ethical and economic constraints related to the design of structures.
4	Analysis	Understand the concept of torsion and columns.
5	Application	Determine deflection of beam by using various method

Prerequisites:

1. Student will be able to Analyze and design structural members
2. Student will be able to Utilize appropriate materials in design.
3. Students will be able to Perform engineering work.
4. Students will be able to provide students with exposure to the systematic methods for solving engineering problems in solid mechanics.
5. Students will be able to build the necessary theoretical background for further structural analysis

Course Outcome Mapping with Program Outcome:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO244.1	2	2	2	2	0	1	1	0	0	0	0	1	1	1	1
CO244.2	2	2	2	2	1	1	0	0	0	1	0	0	1	1	1
CO244.3	2	2	2	1	2	2	2	2	1	1	2	1	1	1	1
CO244.4	3	3	3	3	2	1	2	1	1	1	1	2	2	2	1
CO244.5	3	2	3	2	2	1	2	2	1	2	1	2	2	2	1
CO244 (AVG)	2.4	2.2	2.4	2	1.4	1.2	1.4	1	0.6	1	0.8	1.2	1.4	1.4	1

Course Coverage Module Wise:

Lecture No.	Unit	Topic
1	**1**	**INTRODUCTION:** To Objective, Scope And Outcome Of The Subject
2	2	Student should be able to understand SIMPLE STRESSES AND STRAINS IN DIFFERENT MEMBERS: Stresses In Prismatic & Non Prismatic Members
3	2	Student should be able to understand (Contd.) Simple Stresses And Strains In Different Members
4	2	Student should be able to understand Simple Stresses And Strains In Different Members In Composite Members.
5	2	Student should be able to understand Thermal Stresses
6	2	Student should be able to understand Stresses In Composite Members, Compatibility Condition
7	2	Student should be able to understand Stresses In Composite Members, Compatibility Condition
8	**3**	Student should be able to understand COMPOUND STRESS**:** Two Dimensional Stress System
9	3	Student should be able to understand Stress Resultant, Principal Planes And Principal Stresses
10	3	Student should be able to understand Stress Resultant, Principal Planes And Principal Stresses
11	3	Student should be able to understand State Of Pure Shear Maximum Shear Stress

12	3	Student should be able to understand Mohr's Circle &Its Application
13	3	Student should be able to Introduce To Theories Of Failures
14	**4**	Student should be able to understand BENDING OF BEAMS**:** Bending Moment
15	4	Student should be able to understand Shear Force And Axial Thrust Diagrams For Statically Determinate
16	4	Student should be able to understand Shear Force And Axial Thrust Diagrams For Statically Determinate
17	4	Student should be able to understand Point Of Contra-Flexure, Relation Between Load
18	4	Student should be able to solve problem based on SF And BM.
19	4	Student should be able to solve problem based on SF And BM.
20	4	Student should be able to solve problem based on SF And BM.
21	4	Student should be able to solve problem based on SF And BM.
22	4	Student should be able to solve problem based on SF And BM.
23	5	Student should be able to understand THEORY OF SIMPLE BENDING
24	5	Student should be able to understand Distribution Of Bending And Shear Stresses
25	5	Student should be able to understand (Contd.) Distribution Of Bending And Shear Stresses
26	5	Student should be able to understand Distribution Of Bending And Shear Stresses
27	5	Student should be able to understand Distribution Of Bending And Shear Stresses
28	5	Student should be able to understand Combined Direct And Bending Stress
29	5	Student should be able to understand Combined Direct And Bending Stress
30	6	Student should be able to understand TORSION: Elementary Concepts Of Torsion
31	6	Student should be able to understand Shear Stress In Solid And Hollow Circular Shafts
32	6	Student should be able to understand Angle Of Twist, Power Transmitted By A Shaft
33	6	Student should be able to understand Bending And Torsion
34	7	Student should be able to understand COLUMNS: Short And Long Columns
35	7	Student should be able to understand Slenderness Ratio, Crushing And Buckling Of Column
36	7	Student should be able to understand Short Column Subjected To Axial And Eccentric Loads
37	7	Student should be able to understand Euler's Theory And Its Limitation, Concept Of Effective Length Of
38	7	Student should be able to understand Rankine & Secant Formulae, Middle Third Rule, Core Of A

39	8	Student should be able to understand DEFLECTION OF BEAMS: Differential Relation Between Load
40	8	Student should be able to understand Shear Force, Bending Moment, Slope Deflection.
41	8	Student should be able to understand Slope & Deflection In Determinate
42	8	Student should be able to understand Double Integration Method

TEXT/REFERENCE BOOKS

1. Mechanics of Structures Vol. I & II by S.B Junarkar, Charotar Publishing House, Anand.
2. Strength of Materials & Mechanics of Structures: Vol. I, II by Dr. B.C. PunmiaLaxmi Publications (p) Ltd.
3. Strength of Material by Singer and Pytel, Harper Collins Publishers.
4. Elements of Strength of Materials by Timoshenko & Young, Mc Graw HillBook Co.

Course Level Problems (Test Items):

CO.NO.	Problem description
1	A. What is stress B. Define Hooke's law. C. Define Modulus of Elasticity and Shear Modulus.
2	A. Define Resilience, Proof Resilience & Modulus of Resilience. Give expression for Stress due to gradually applied load & suddenly applied load. B. Explain the classification of Columns. c. C. Derive the Torsion Equation D. List the assumptions made in theory of simple bending
3	A. What must be the length of a 5m diameter aluminum wire be so that it can be so twisted through one complete revolution without exceeding a shearing stress of 42 N/mm2 . Let G=2.7X104 N/mm2. B. Define the following. a) Slenderness ratio b) Buckling. C. Find the safe compressive load on a hollow C.I. column, one end rigidly fixed and other hinged, of 150mm external diameter and 100mm internal diameter and 4m long. Use Euler's formula with F.O.S. of 5 and fc = 350 N/mm2

4	A. A hollow shaft is to transmit is to 400 KW power at 90 r.p.m. If fs = 74 N/mm2 and internal diameter is 0.6 times the external diameter, then find both the diamers assuming the following relations Tmax= 1.35 Tmean. d. B. A laminated spring 600mm long is made up of plates each being 60mm wide and 8mm thick. Fing the number of plates required to enable the spring to carry a central point load of 4000N if the permissible bending stress is 120N/mm2 . Also find deflection if E=200KN/mm2 .
5	A. A closed coil helical spring is to carry a load of 500 N. The mean coil diameter is 10 times that of wire diameter. Calculate the diameters of spring and coil if the maximum shear stress in the material of the spring is 80 N/mm2 . B. Define any five mechanical properties of a material. h. C. Describe the functions of a spring. Write the formulas for calculating stiffness for springs connected in parallel and series..

Assessment Methodology:

1. Practical exam in lab where they have to analyze problem statement. (Once in a week)
2. Assignments one from each unit.
3. Midterm subjective paper based on topics as mentioned in the modules. (Twice during the semester)
4. Final paper at the end of the semester subjective

Teaching and Learning resources unit-wise:

Simple Stress and Strain.

Video Tutorials: https://youtu.be/YkdQB0JnJD4

Theory concepts: https://www.jntua.ac.in/gate-online-classes/registration/downloads/material/a158938439610.pdf

Sample ppt: https://www.careerride.com/mcq-tag-wise.aspx?Key=Simple%20Stresses%20and%20Strains&Id=16

A. Torsion

Video Tutorials: https://youtu.be/g5h2E2jMqmc

Theory concepts: https://en.wikipedia.org/wiki/Torsion_(mechanics)

Sample Quiz: https://quizlet.com/194524432/torsion-flash-cards/

B. Spring

Video Tutorials: https://youtu.be/YAJIromkA2U

Theory concepts: https://edurev.in/studytube/Chapter-9-Springs-Strength-of-Material--Mechanical/95956b26-9268-43d8-ba14-0710ccca152e_t

Sample Quiz: https://www.javatpoint.com/spring-quiz

A. Deflection.

Video Tutorials: https://youtu.be/4Xd18oVl80c

Theory concepts: https://en.wikipedia.org/wiki/Deflection_(engineering)#:~:text=In%20engineering%2C%20deflection%20is%20the,an%20angle%20or%20a%20distance.

Sample Quiz: https://edurev.in/course/quiz/attempt/-1_Test-Deflection-Theories-of-Failure-2/63527653-48b9-4608-8fef-a4e99aae92d2

B. Column

Video Tutorials: https://youtu.be/XxFn138C1H0

Theory concepts: https://www.rajagiritech.ac.in/Home/mech/Course_Content/Semester%20III/ME%20201%20Mechanics%20of%20Solids/Module%206.pdf

Sample Quiz: http://www.texalab.com/prepare.php?dept=104-Mechanical_Engineering&sub=204-SOM&page=4

Previous Year Question Papers:

RTU paper

3E1621

[Total No. of Pages : 4

3E1621

B.Tech. III semester (Main/Back) Examination Dec. - 2016
Civil Engineering
3CE1A Strength of Materials - I

Time : 3 Hours

Maximum Marks : 80
Min. Passing Marks : 26

Instructions to Candidates:

*Attempt any **five** questions, selecting one question from **each unit**. All questions carry equal marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.*

Unit - I

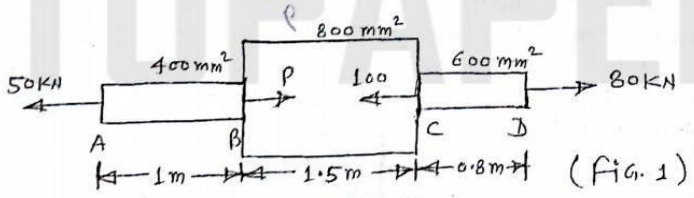
1. a) Draw a neat diagram of stress strain curve for a mild steel bar subjected to tensile load. Also define the following terms :
   i) Gauge length
   ii) Yield point
   iii) Proof stress
   iv) Factor of safety **(8)**

   b) A steel rod 5 m long and 30 mm in diameter is subjected to an axial tensile load of 50 KN. Determine the change in length, diameter and change in volume of the rod. Take E = 2×10^5 N/mm^2 and Poisson's ratio $\gamma = 0.25$ **(8)**

OR

1. a) Write short notes on the following :
   i) Complementary shear stress
   ii) Elastic constants. **(4×2=8)**

   b) A steel bar ABCD of varying sections is subjected to the axial forces as shown in fig. 1. Find the value of P necessary for equilibrium. If E = 210 KN/mm^2. Determine total elongation of the bar. **(8)**



(fig. 1)

Unit - II

2. a) What do you understand by principal stresses and principal planes. **(8)**

b) In a two dimensional problem the stresses at a point are 80 MPa and 50 MPa both tensile acting on two mutually perpendicular planes in normal direction. If the major principal stress is limited to 120 MPa, find out the shear stress on the planes. Also find the magnitudes of minor principal stress, maximum shear stress and position of principal planes. **(8)**

OR

2. a) Explain the state of simple shear. **(4)**

b) Determine the moment of Inertia of an I-section as shown in fig. 2 about its centroidal axes about x-x axis and y-y axis. **(12)**

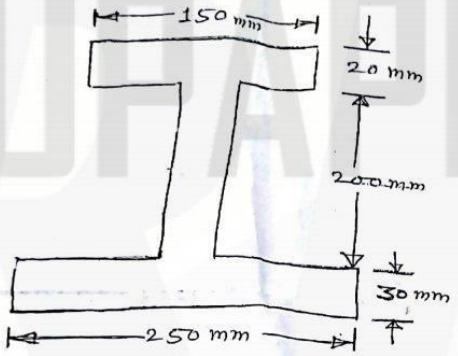


Fig. 2

Unit - III

3. a) Describe the assumptions used in the analysis of thin cylinders. **(4)**

b) Derive the Euler's theory for long columns which have both ends hinged and its limitations. **(8)**

c) Describe the middle third rule for eccentrically loaded compressive members. **(4)**

OR

3. a) Define slenderness ratio of a column. What is its importance? Write down the values of effective length of a column for different end conditions. **(8)**

b) Compare the ratio of the strength of solid steel column to that of a hollow column of the same cross sectional area. The internal diameter of the hollow column is 3/4 of the external diameter. The column have the same length and are pinned at the ends. **(8)**

Unit - IV

4. a) Derive the relationship between load, shear force and bending moment. **(8)**

b) Draw shear force and bending moment diagrams showing the values at different points for the beam as shown in fig.3 **(8)**

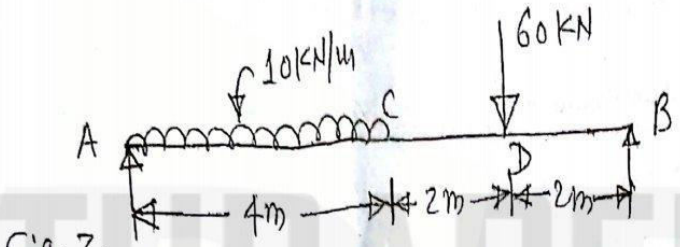


Fig. 3.

OR

4. a) Draw the shear force and bending moment diagram for the cantilever beam as shown in fig. 4 **(6)**

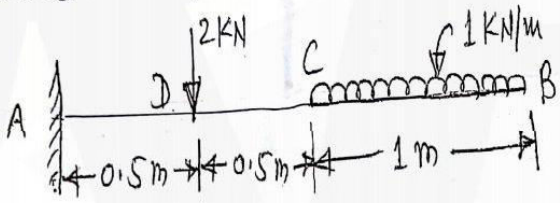


Fig. 4

b) Draw shear force and bending moment diagram for over hanging beam as shown in fig.5. Locate point of contraflexure. **(10)**

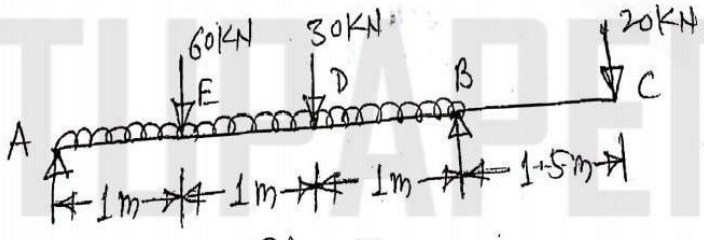


Fig 5

Unit - V

5. a) Write the assumptions used in bending theory. **(4)**

b) A steel tube, 4m long, having external and internal diameters of 80 mm and 50 mm respectively is freely supported at each end carries a point load of 'W' Newtons at a distance of 1.5 m from one end. Evaluate 'W' If the maximum bending stress is not to exceed 120 N/mm^2. **(12)**

OR

5. a) Show that for a beam of circular cross section, the maximum shear stress is 4/3 times the average shear stress. **(4)**

b) A simply supported beam of rectangular cross section of dimension 150×300 mm is having span of 4.5 m. It is loaded with a u.d.l of 8 kN/m compute shear stress developed on a layer 60 mm above the neutral axis of a section located at 1.5 m from the left support. **(12)**