MECHANICAL

DEPARTMENT

2022-23

MOS

PREPARED BY

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Techno India NJR Institute of Technology

Course File

Session 2022-23

MOS (3ME-07)

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RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

2nd Year - III Semester: B.Tech. (Mechanical Engineering)

3ME4-07 : MECHANICS OF SOLIDS

Credit: 4 **Max. Marks: 200 (IA:40, ETE:160)**

3L+1T+0P **End Term Exam: 3 Hours**

S.No	CONTENTS	Hours
1	**Stress and Strain:** Elementary definition of stress and strain, stress-strain relationship, elastic, plastic and visco-elastic behavior of common materials in tension and compression test, stress-strain curves, Hooke's law, Poisson's ratio, elastic constants and their relations for an isotropic hookean material, anisotropic and orthotropic materials.	3
	Tension, compression, shearing stress and strain, thermal stresses, composite bars, equations of static equilibrium, concept of free body diagram. Strain energy due to axial loading.	5
2	**Members Subjected to Flexural Loads:** Theory of simple bending, bending moment and shear force diagrams for different types of static loading and support conditions on beams.	4
	bending stresses, section modulus and transverse shear stress distribution in circular, hollow circular, I, Box, T, angle sections etc. Strain energy due to bending.	5
3	**Principal Planes, Stresses and Strains:** Members subjected to combined axial, bending and torsional loads, maximum normal and shear stresses, concept of equivalent bending and equivalent twisting moments, Mohr's circle of stress and strain.	5
	Theories of Elastic Failures: The necessity for a theory, different theories, significance and comparison, applications.	2
4	**Torsion:** Torsional shear stress in solid, hollow and stepped circular shafts, angular deflection and power transmission capacity. Strain energy due to torsional loads.	4
	Stability of Equilibrium: Instability and elastic stability, long and short columns, ideal strut, Euler's formula for crippling load for columns of different ends, concept of equivalent length, eccentric loading, Rankine formulae and other empirical relations.	3
5	**Transverse Deflection of Beams:** Relation between deflection, bending moment, shear force and load, transverse deflection of beams and shaft under static loading, area moment method, direct integration method.	6
	Thin-walled Pressure Vessels: Stresses in cylindrical and spherical vessels	2
	TOTAL	39

Course Overview:

Strength of materials is **the discipline related to calculation of stresses and strains in structures and mechanical components**. ... In order to do so, we define the term stress as a measure for internal force per area acting inside a structure.

Course Outcomes:

CO. NO.	Cognitive Level	Course Outcome
1	Analysis	To understand the basics of material properties, stress and strain
2	Synthesis	To apply knowledge of mathematics, science, for engineering applications
3	Synthesis	Ability to identify, formulate, and solve engineering & real life problems
4	Synthesis	Ability to design and conduct experiments, as well as to analyze and interpret data
5	Analysis	To Design Pressure Vessels and Find Stress Concentration Factor.

Prerequisites:

1. Basic Knowledge about Free Body Diagram
2. Must have completed the course on Engineering Mechanics.

Course Scheme -

THEORY												
SN	Category	Course		Contact hrs/week			Marks				Cr
		Code	Title	L	T	P	Exm Hrs	IA	ETE	Total	
1	BSC	3ME2-01	Advance Engineering Mathematics-I	3	0	0	3	30	120	**150**	**3**
2	HSMC	3ME1-02/ 3ME1-03	Technical Communication/ Managerial Economics and Financial Accounting	2	0	0	2	20	80	**100**	**2**
3	ESC	3ME3-04	Engineering Mechanics	2	0	0	2	20	80	**100**	**2**
4	PCC	3ME4-05	Engineering Thermodynamics	3	0	0	3	30	120	**150**	**3**
5		3ME4-06	Materials Science and Engineering	3	0	0	3	30	120	**150**	**3**
6		3ME4-07	Mechanics of Solids	3	1	0	3	40	160	**200**	**4**
			Sub Total	16	1	0		170	680	**850**	**17**

Course Outcome Mapping with Program Outcome:

Mechanics of Solids Year of study: 2021-22															
Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	0	2	1	1	1	2	0	1	1	1	1
CO2	2	2	2	1	1	2	1	0	1	2	0	1	1	0	1
CO3	2	2	2	2	1	1	1	1	1	2	0	1	1	0	1
C04	2	2	1	1	1	1	1	0	1	1	0	1	1	1	1
C05	2	2	1	1	1	1	1	0	1	1	0	1	1	1	1
Average	2.00	2.00	1.60	1.40	0.80	1.40	1.00	0.40	1.00	1.60	0.00	1.00	1.00	0.60	1.00

Course Coverage Module Wise:

Lecture No.	Unit	Topic
1	1	ELEMENTARY DEFINITION OF STRESS AND STRAIN: stress strain relationship, elastic, plastic and visco-elastic behavior of common materials in tension and compression test, stress-strain curves
2	1	Hooke's law, Poisson's ratio, elastic constants and their relations for an isotropic hookean material
3	1	Anisotropic and orthotropic materials.
4	1	Tension, compression, shearing stress
5	1	strain, thermal stresses, composite bars
6	1	equations of static equilibrium,
7	1	concept of free body diagram.
8	1	Strain energy due to axial loading
9	2	THEORY OF SIMPLE BENDING
10	2	bending moment and shear force diagrams for different types of static loading and support conditions on beams.(Point load problem)

11	2	bending moment and shear force diagrams for different types of static loading and support conditions on beams.(UDL Problem)
12	2	bending moment and shear force diagrams for different types of static loading and support conditions on beams.(UVL Problem)
13	2	bending stresses
14	2	section modulus and transverse shear stress distribution in circular
15	2	section modulus and transverse shear stress distribution in hollow circular, I section.
16	2	section modulus and transverse shear stress distribution in T section and angle sections.
17	2	Strain energy due to bending
18	3	EQUIVALENT BENDING & TWISTING
19	3	Members subjected to combined axial bending and torsional loads,
20	3	concept of equivalent bending and equivalent twisting moments
21	3	maximum normal and shear stresses
22	3	Mohr's circle of stress and strain.
23	3	The necessity for a theory, different theories
24	3	Significance and comparison, applications.
25	4	TORSION: Torsional shear stress in solid, hollow
26	4	Torsional shear stress in Angular stepped shaft.
27	4	angular deflection and power transmission capacity
28	4	Strain energy due to torsional loads.
29	4	Instability and elastic stability, long and short columns, ideal strut
30	4	Euler's formula for crippling load for columns of different ends, concept of equivalent length

31	4	Eccentric loading, Rankine formulae and other empirical relations.
32	5	BENDING MOMENT
33	5	Relation between deflection bending moment, shear force and load
34	5	transverse deflection of beams and shaft under static loading
35	5	transverse deflection of beams and shaft under static loading(Numerical Problem)
36	5	Area moment method,.
37	5	direct integration method
38	5	Stresses in cylindrical
39	5	Stresses in Spherical Vessels

TEXT/REFERENCE BOOKS

1. BANSAL, R. K., "A TEXTBOOK OF STRENGTH OF MATERIALS LAXMI PUBLICATIONS.

2. PUNMIA, JAIN AND JAIN, "MECHANICS OF MATERIALS", LAXMI PUBLICATION.

Teaching and Learning resources:

- **MOOC (NPTEL): -** https://drive.google.com/drive/u/1/folders/1gimy5aZo207_Oja05Hw6JE2qNjyotPOz.

  YouTube Videos Link – https://www.youtube.com/c/TECHNICALCLASSES_TC

- **Assessment Methodology:**

1. Two Midterm exams where student have to showcase subjective learning.
2. Final Exam (subjective paper) at the end of the semester.
3. Surprise Test

Last Year Paper.

3E1210

Roll No. _____ [Total No. of Pages : 3

3E1210

B.Tech. III Sem. (Main) Examination, April/May - 2022
Automobile Engineering
3AE4-07 Mechanics of Solids
AE, ME

Time : 3 Hours

Maximum Marks : 70

Instructions to Candidates:

Attempt ***all ten*** *questions from* ***Part A****. All* ***five*** *questions from* ***Part B*** *and* ***three*** *questions out of* ***Five*** *questions from* ***Part C****.*

Schematic diagrams must be shown wherever necessary. Any ***data missing may*** *suitably be assumed and stated clearly. Units of quantities* ***used/calculated must*** *be stated clearly.*

Use of following supporting material is permitted during examination. ***(Mentioned*** *in form No. 205)*

PART - A (Words limit 25)

(10×2=20)

A. Draw stress-strain diagram (Tensile test diagram).
2. Define the ultimate strength.
3. What is the Poisson's ratio?
4. Explain modulus of rigidity.
5. Write down the maximum shear stress theory.
6. Write down the maximum strain energy theory.
7. Write down the expression for equivalent twisting moment for shaft subjected to torsion and bending forces?
8. Write down the Rankine general formula for Columns.
9. Write the relationship among twisting moment, shear stress and torsional rigidity.
10. Write down the general bending moment equation having modulus of elasticity and moment of inertia.

PART - B (Words limit 100)

(5×4=20)

1. What are the "complimentary shear stresses"? Using Mohr circle, derive expression for normal and tangential stresses on a diagonal plane of a piece of material in pure shear.

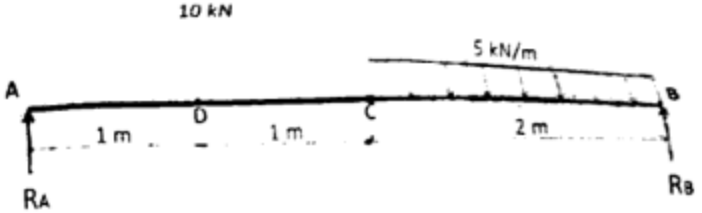
2. A beam AB of 4 metre span is simply supported at the ends and is loaded as shown in the following figure. Determine

i) Deflection at point C.

ii) Maximum deflection and

iii) Slope at the end A.

Take $E = 2 \times 10^5$ N/mm² and $I = 1000$ cm⁴



3. A copper tube of 50 mm internal diameter, 1 m long and 1.25 mm thick has closed ends and is filled with the water under pressure. Neglecting any distortion of the end plates, determine the alteration of pressure when an additional volume of 3 cubic centimetres of water is pumped into the tube.

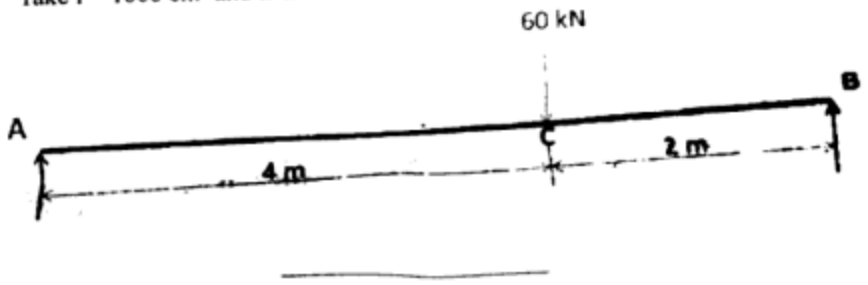
4. A hollow steel shaft 4 m long is to transmit 150 kW power at 150 R.P.M. The total angle of twist in this length is not to exceed 2.5 degree and the allowable shear stress is 60 N/mm². Determine the inside and outside diameters if $N = 0.082 \times 10^6$ N/mm².

5. Using area moment method, compute

i) Deflection at point C,

ii) Slope at point B for the Beam AB as shown in the following figure.

Take $I = 1000$ cm⁴ and is $E = 2 \times 10^5$ N/mm².



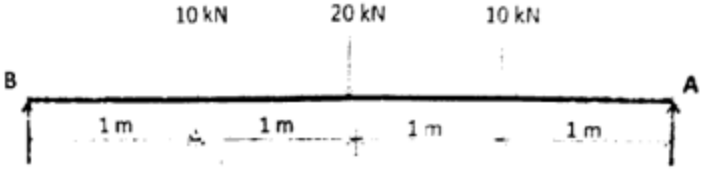
2. At a point in an elastic material under strain, there are normal stresses of 50N/mm² and 13 N/mm² respectively at right angles to each other with a shearing stress of 25 N/mm². Find the principal stresses and position of principal planes if:

i) 50 N/mm² is tensile and 30 N/mm² is also tensile.

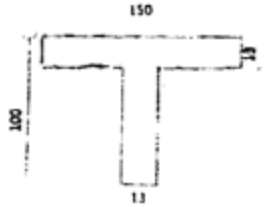
ii) 50 N/mm² is tensile and 30 N/mm² is compressive.

Find also the maximum shear stress and its plane in both the cases using mohr circle method.

3. Draw the shear force diagram and Bending moment diagram for following simply supported beam with point loads.



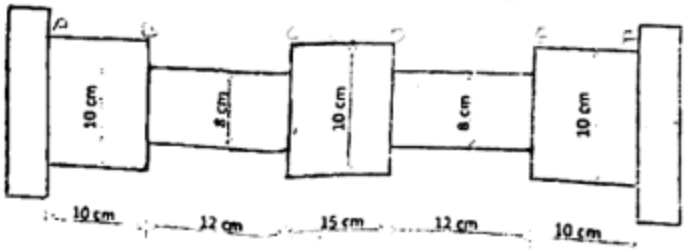
4. The cross section of a joist is a T section 150 mm × 200mm×13 mm with 150 mm side horizontal. Find the maximum intensity of shear stress and sketch the distribution of stress across the section if it has to resist a shear force of 80 kN.



5. A mild steel column is of hollow circular section with 120 mm external diameter and 90 mm internal diameter. The column is 3m long and hinged at both the ends. Calculate the maximum permissible load with an eccentricity of 20 mm if the maximum compressive stress is limited to 80 N/mm². Take E=2.05×10⁵ N/mm²

PART - C (Any three) (3×10=30)

6. A rod shown in the following fig. is subjected to a pull of 500 kN on the ends. Taking E = 205 kN/mm², find the extension of the rod.



3E1119

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3E1119

B. Tech. III - Sem. (Main) Exam., Dec. - 2018

PCC Automobile Engineering

3AE4 – 07 Mechanics of Solids

AE, ME

Time: 3 Hours **Maximum Marks: 160**

Instructions to Candidates:

Attempt all ten questions from Part A, five questions out of seven questions from Part B and four questions out of five from Part C.

Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used /calculated must be stated clearly.

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL 2. NIL

PART – A

(Answer should be given up to 25 words only) **[10×3=30]**

All questions are compulsory

Q.1 Define the following –

(i) Ductility

(ii) Toughness

(iii) Malleability

Q.2 Discuss stress – strain diagram for ductile materials.

Q.3 What do you understand by Poisson's ratio.

Q.4 Define modulus of Elasticity (E) & modulus of Rigidity (G).

Q.5 Distinguish between simply supported beam and fixed beam.

Q.6 Define bending moment & its sign convention.

Q.7 What do you understand by torsion. Write the equation of torsion.

Q.8 Distinguish between principal stress and principal strain.

Q.9 Define maximum principal stress theory along with its graphical representation.

Q.10 What is the difference between a column and a strut?

PART – B

(Analytical/Problem solving questions) **[5×10=50]**

Attempt any five questions

Q.1 Derive an expression showing relation between modulus of elasticity and modulus of rigidity. [10]

Q.2 Derive the following relation – [10]

$$M = E I \frac{d^2 y}{d x^2}$$

Q.3 What is the use of theories of failure? Name them & discuss in brief. [10]

Q.4 A circular rod of steel 10 mm diameter is tested for tension and it was observed that when tension was 11 kN, the total extension on a 300 mm length was 0.20 mm. Find the value of E. [10]

Q.5 Explain the different methods of determining the deflection of statically indeterminate beams. [10]

Q.6 Explain the stresses in thin walled pressure vessels. [10]

Q.7 What is area moment method? Where is it used? [10]

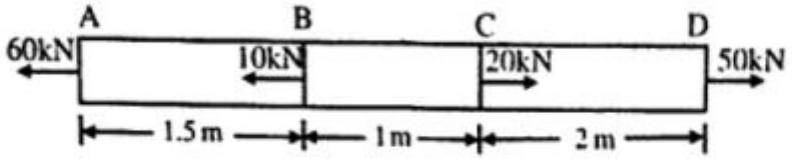
PART – C

(Descriptive/Analytical/Problem Solving/Design Question) **[4×20=80]**

Attempt any four questions

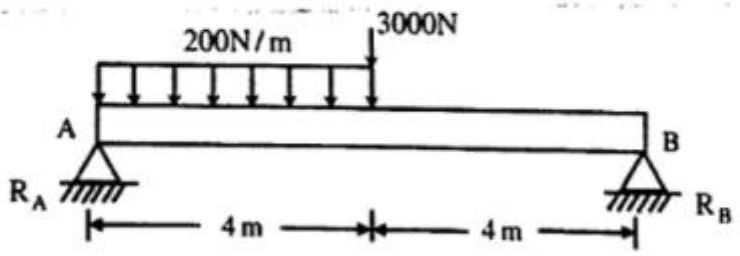
Q.1 (a) Explain the concept of free body diagram taking a suitable example. [10]

(b) A steel bar of 25 mm diameter is acted upon by forces as shown in figure. Determine the total elongation of the bar. http://rtuonline.com [10]



Q.2 (a) Explain the various types of static loading and support conditions in beams. [10]

(b) Draw the SFD & BMD of a loaded beam as shown in figure – [10]



Q.3 (a) Explain and compare the different theories of elastic failures. [10]

(b) If the principal stresses at a point in an elastic material are 2f tensile, f tensile and $\frac{1}{2}$ f compressive, calculate the value of 'f' at failure according to five different theories for failure to just take place. The elastic limit in simple tension is 200 N/mm^2 and Poisson's ratio = 0.3. [10]

Q.4 (a) Define torsion and torsion rigidity. [6]

(b) Two shafts of same material & lengths are subjected to save torque. If the first shaft is a solid circular section & second shaft is of hallow section whose internal dia. is 2/3 of outer dia. & the maximum shear stress developed in each shaft is same. Compare the weight of shaft. http://rtuonline.com [14]

Q.5 A thin cylinder shell 120 cm dia 1.5 cm thick 6 m long is subjected to internal fluid pressure 2.5 N/mm^2 of the value E = 2×10^5 N/mm^2, $\mu = 0.3$. [20]

Find –

(i) Change in dia.

(ii) Change in length

(iii) Change in volume

31100

311007

B. Tech. III Sem. (Main) Exam., Dec. - 2019

Mechanical Engineering

3ME4-07 Mechanics of Solids

Time: 3 Hours **Maximum Marks: 160**

Instructions to Candidates:

Part – A: *Short answer questions (up to 25 words) 10 × 3 marks = 30 marks. All ten questions are compulsory.*

Part – B: *Analytical/Problem Solving questions 5 × 10 marks = 50 marks. Candidates have to answer five questions out of seven.*

Part – C: *Descriptive/Analytical/Problem Solving questions 4 × 20 marks = 80 marks. Candidates have to answer four questions out of five.*

Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.

Use of following supporting materials is permitted during examination. (Mentioned in form No. 205)

1. NIL 2. NIL

PART - A

Q.1 Explain Poisson's ratio. [3]

Q.2 What is thermal stress? [3]

Q.3 Define section modulus. [3]

Q.4 Write the flexural formula for members subjecting bending. [3]

Q.5 Write the equations for principal stresses, for a member subjecting σ_1, σ_2 as two mutually perpendicular planer normal stress & τ, as shear stress in that plane. [3]

Q.6 Write down names of any three theories of failure. [3]

Q.7 Write the equation of induced torsional shear stress in a shaft having diameter 'd' and torque applied is T. [3]

Q.8 Explain slenderness ratio related to column. [3]

Q.9 What is cantilever beam? [3]

Q.10 Write down the equation for hoop or circumferential stress for thin cylinder. [3]

PART – B

Q.1 Derive the expression for elongation of circular rod due to self-weight, when it is hanged at one end. [10]

Q.2 A steel rod having 30mm diameter and 300mm long is subjected to tensile force 'P' acting axially. The temperature of the rod is then raised through 80°C and the total extension measured is 0.35mm. Calculate the value of 'P'. Take $E_s = 200GN/M^2$ and $\alpha_s = 12\times10^{-6}$ per °C. [10]

Q.3 The intensity of loading in a simply supported beam of 8m span varies gradually from 2kN/m at one end to 6kN/m at the other end. Draw the shear force and bending moment diagrams. [10]

Q.4 Show that at a plane, in a material subjected to two dimensional stress, the sum of the normal components of stresses on any two mutually perpendicular plane is constant. [10]

Q.5 A solid shaft of 100mm diameter is to transmit 120 kW at 100rpm. Find the maximum intensity of shear stress induced and the angle of twist for a length of 8 meter. [10]

Q.6 Describe Euler's theory for columns, including various assumptions and applications. [10]

Q.7 Explain various stresses developed in a thin cylindrical cell subjected to internal fluid pressure. [10]

PART – C

Q.1 Briefly explain various elastic constants. Derive expression for inter-relation of various elastic constants. [8+12=20]

Q.2 Derive an expression for shear stress distribution in a solid circular section. [20]

Q.3 At a point in a material under stress, intensity of resultant stress on a certain plane is 50 MN/m^2 (tensile) inclined at 30° to the normal of that plane. The stress on a plane at right angles to this has a normal tensile component of intensity of 30 MN/m^2.

Draw the Mohr's circle for above configuration of stresses and find –

(il) Principal stress & principal plane orientation.

(ii) Maximum Shear stress & its orientation. [10+5+5=20]

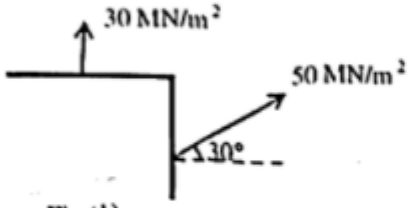


Fig.(1)

Q.4 Two shafts of same materials and same length are subjected to the same torque. If the first shaft is of a solid circular section and the second shaft is of hollow circular section whose internal diameter is 2/3 of the outside and in each shaft, maximum shear is same, then compare the weight of two shaft (calculate weight ratio). [20]

Q.5 A cantilever beam of 100mm width and 200mm depth is loaded as shown in figure. Find the slope and deflection at the free end A. Take E=2.1×10^8 kN/m^2. [20]