Total No. of Questions: 22

Enrollment No : _____

MEDICAPS UNIVERSITY

Faculty of Engineering

End Semester Examination May 2025

AU3CO19 / AU3CO52 / ME3CO19 / ME3CO43 Mechanics of Materials

Programme	:	B.Tech.	**Branch/Specialisation**	:	AU/ME
Duration	:	3 hours	**Maximum Marks**	:	60

Note: *All questions are compulsory. Internal choices, if any, are indicated. Assume suitable data if necessary. Notations and symbols have their usual meaning.*

Section 1 (Answer all question(s))

Marks CO BL

Q1. What is the ratio of lateral strain to longitudinal strain called? **1 1 1**

- ○ Young's modulus
- ○ Bulk modulus
- ○ Shear modulus
- ◉ Poisson's ratio

Q2. Residual stress in a material is: **1 1 1**

- ○ The stress due to impact loading
- ○ The stress due to temperature changes
- ◉ The stress that remains after the external force is removed
- ○ The stress due to bending

Q3. In three-dimensional Mohr's Circle analysis, how many circles are generally drawn? **1 2 1**

- ○ One
- ○ Two
- ◉ Three
- ○ Four

Q4. In a thin-walled pressure vessel, the circumferential (hoop) stress is: **1 2 1**

- ◉ Twice the longitudinal stress
- ○ Equal to the longitudinal stress
- ○ Half of the longitudinal stress
- ○ Zero

Q5. Shear stress in a beam varies: **1 3 1**

- ○ Linearly from top to bottom
- ◉ Parabolically across the section
- ○ Uniformly across the section
- ○ Exponentially from the center

Q6. In pure bending, the neutral axis of the beam is subjected to: **1 3 1**

- ○ Maximum tensile stress
- ○ Maximum compressive stress
- ◉ Zero stress
- ○ Maximum shear stress

Q7. A stepped shaft is used to: **1 4 1**

- ◉ Reduce weight while maintaining strength
- ○ Increase the shear stress
- ○ Make manufacturing easier
- ○ Increase the moment of inertia

Q8. The angle of twist in a circular shaft depends on: **1 4 1**

- ○ Applied torque
- ○ Shaft length
- ○ Shaft material properties
- ◉ All of the above

Q9. What is the basic assumption of Euler's theory of buckling? **1 5 1**

- ○ Material follows Hooke's Law
- ○ Column is perfectly straight before loading
- ○ Load is applied axially
- ◉ All of the above

Q10. The crippling load for a column is also known as: **1 5 1**

- ○ Ultimate load
- ◉ Buckling load
- ○ Yield load
- ○ Factor of safety

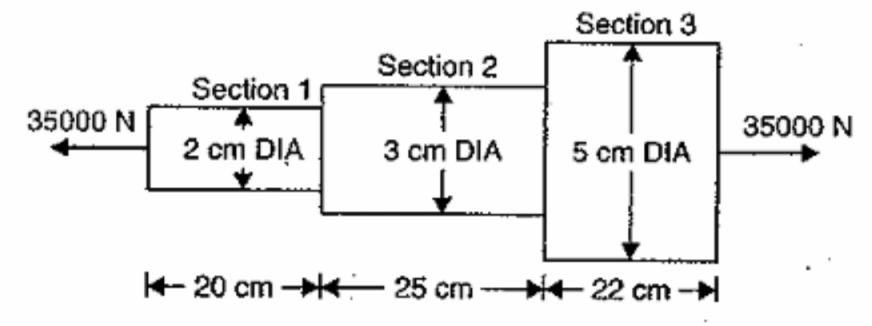
Section 2 (Answer all question(s))

Marks CO BL

Q11. Define the terms: **2 1 2**
(i) Young's modulus
(ii) Modulus of rigidity

Rubric	Marks
Explain Young's modulus	1
Explain Modulus of rigidity	1

Q12. An axial pull of 35000 N is acting on a bar consisting of three lengths as shown in figure. If the Young's modulus = 2.1×10^5 N/mm², determine: **3 1 2**
(i) Stresses in each section and
(ii) Total extension of the bar.



Rubric	Marks
Calculate area of each section	1
Calculate Stresses in each section and	1
Calculate total extension of the bar.	1

Q13. (a) Calculate the modulus of rigidity and bulk modulus of a cylindrical bar of diameter 30 mm and length 1.5 m if the longitudinal strain in a bar during a tensile stress is four times the lateral strain. Find the change in volume, when the bar is subjected to a hydrostatic pressure of 100N/mm². Take $E = 1 \times 10^5$ N/mm². **5 1 3**

Rubric	Marks
Calculate volume of bar and poisson's ration	1
Calculate modulus of rigidity and bulk modulus	2
Calculate change in volume	2

(OR)

(b) A steel rod of 3 cm diameter and 5 m long is connected to two grips and the rod is maintained at a temperature of 95°C. Determine the stress and pull exerted when the temperature falls to 30°C, if
(i) the ends do not yield, and
(ii) the ends yield by 0.12 cm.
Take $E = 2 \times 10^5$ MN/m² and $\alpha = 12 \times 10^{-6}$/°C.

Rubric	Marks
When the ends do not yield, Calculate stress and pull	2
When the ends yield by 0.12 cm, Calculate stress and pull	3

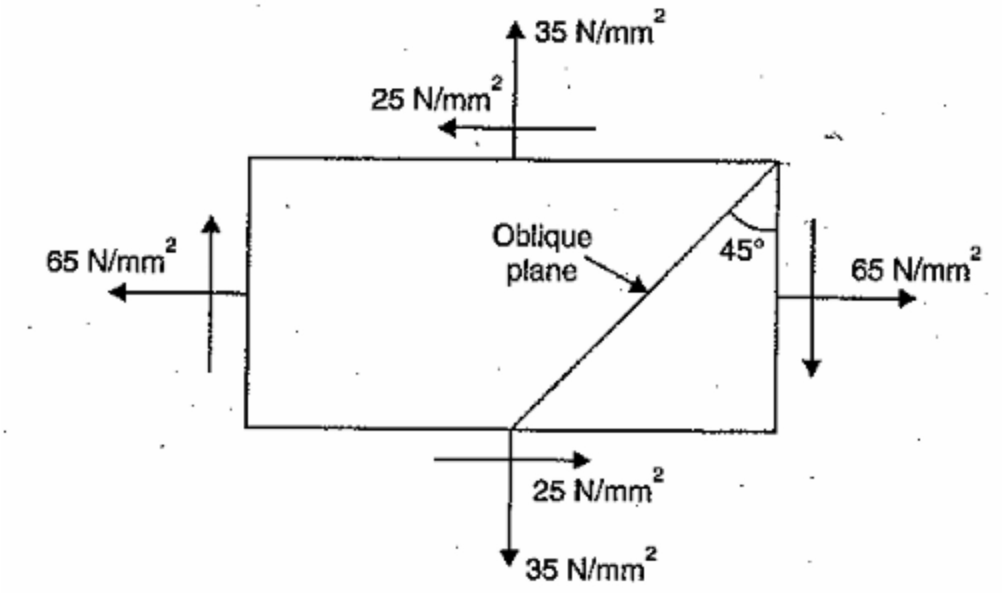
Section 3 (Answer all question(s))

Marks CO BL

Q14. Explain the terms with neat and clean diagram:- **3 2 2**
(a) Principal planes
(b) Principal stresses

Rubric	Marks
Draw diagram	1
Explain principal plane	1
Explain principal stresses	1

Q15. (a) A point in a strained material is subjected to stresses shown in figure. Using Mohr's circle method, determine the normal and tangential stresses across the oblique plane. Check the answer analytically. **7 2 3**



Rubric	Marks
Draw Mohr's circle and calculate normal and tangential stresses	5
Check the answer analytically.	2

(OR)

(b) Derive an expression for circumferential stress and longitudinal stress for a thin shell subjected to an internal pressure.

Rubric	Marks
Diagram	2
expression for circumferential stress	3
expression for longitudinal stress	2

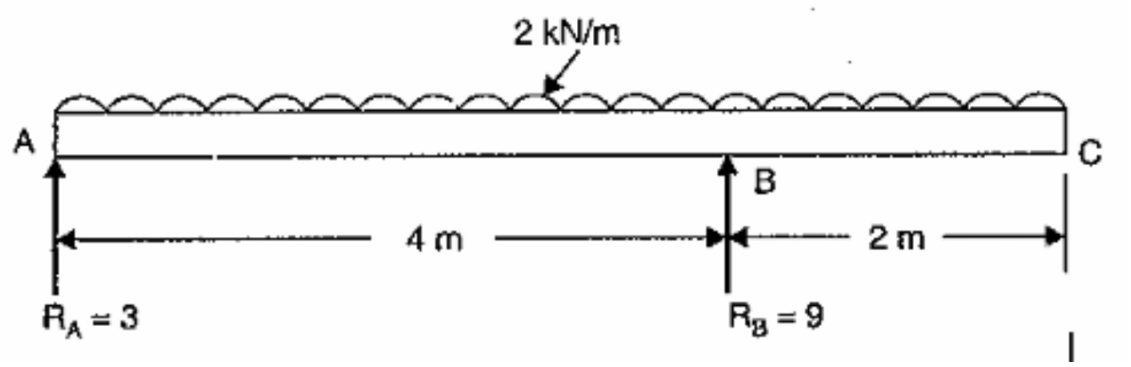
Section 4 (Answer all question(s))

Marks CO BL

Q16. Define and explain the following terms: **3 3 2**
(i) Bending moment
(ii) Shear force diagram
(iii) Bending moment diagram

Rubric	Marks
Explain Bending moment	1
Explain Shear force diagram	1
Explain Bending moment diagram	1

Q17. (a) Draw the shear force and bending moment diagrams for the overhanging beam carrying uniformly distributed load of 2 kN/m over the entire length as shown in figure. Also locate the point of contraflexure. **7 3 3**



Rubric	Marks
Calculate reaction at support	1
Calculate Shear force at different point and draw SFD	2
Calculate Bending Moment at different point and draw BMD	3
locate the point of contraflexure	1

(OR)

(b) A beam of cross-section of an isosceles triangle is subjected to a shear force of 30 kN at a section where base width = 150 mm and height = 450mm. Determine:
(i) Horizontal shear stress at the neutral axis,
(ii) The distance from the top of the beam where shear stress is maximum, and
(iii) Value of maximum shear stress.

Rubric	Marks
Calculate shear stress at the neutral axis	2
Calculate distance from the top of the beam where shear stress is maximum	4
Calculate maximum shear stress	1

Section 5 (Answer all question(s)) **Marks CO BL**

Q18. Define the terms: **3 4 1**
(i) Torsion
(ii) Torsional rigidity
(iii) Polar modulus

Rubric	Marks
Define Torsion	1
Define Torsional Rigidity	1
Define Polar modulus	1

Q19. (a) A steel shaft ABCD having a total length of 2.4 m consists of three lengths having different sections as follows: **7 4 1**
AB is hollow having outside and inside diameters of 80 mm and 50 mm respectively and BC and CD are solid, BC having a diameter of 80 mm and CD a diameter of 70mm. If the angle of twist is the same for each section, determine the length of each section and the total angle of twist if the maximum shear stress in the hollow portion is 50 N/mm². Take C = 8.2 × 10⁴ N/mm².

Rubric	Marks
Calculate polar moment of inertia of each section	2
Calculate length of each section	3
Calculate total angle of twist	2

(OR)

(b) Prove that the strain energy stored in a body due to torsion is given by,

$$U = \frac{T^2}{4C} \times V$$

where
T = Shear stress on the surface of the shaft,
C = Modulus of rigidity, and
V = Volume of the body.

Rubric	Marks
Derive expression for strain energy stored in a body.due to torsion	7

Section 6 (Answer any 2 question(s))

Marks CO BL

Q20. Define the terms **5 5 2**
(i) Failure of column
(ii) Radius of gyration
(iii) Slenderness ratio
(iv) Crippling load

Rubric	Marks
Define Failure of column	2
Define Radius of gyration	1
Define Slenderness ratio	1
Define Crippling load	1

Q21. A hollow alloy tube 5 m long with external and internal diameters 40 mm and 25 mm respectively was found to extend 6.4 mm under a tensile load of 60 kN. Find the buckling load for the tube when used as a column with both ends pinned. Find the safe load for the tube, taking a factor of safety = 4. **5 5 3**

Rubric	Marks
Calculate moment of inertia	1
Calculate Young's modulus	2
Calculate buckling load	1
Calculate safe load	1

Q22. A hollow cylindrical cast iron column is 4 m long with both ends fixed. Determine the minimum diameter of the column if it has to carry a safe load of 250 kN with a factor of safety of 5. Take the internal diameter as 0.8 times the external diameter. **5 5 3**

Take $\sigma_c = 550\ N/mm^2$ and $a = \frac{1}{1600}$ in Rankine's formula.

Rubric	Marks
Calculate Crippling load	1
Calculate moment of inertia of column	1
calculate radius of gyration	1
Calculate external and internal diameter	2

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