Total No. of Questions: 21

Enrollment No : _____

MEDICAPS UNIVERSITY

Faculty of Engineering

End Semester Examination May 2025

RA3CO23 Strength of Materials for Mechanical Engineers

Programme	:	B.Tech.	**Branch/Specialisation**	:	RA
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 does Poisson's ratio represent? **1 1 1**

- (•) The ratio of lateral strain to axial strain.
- ( ) The ratio of axial strain to lateral strain.
- ( ) The ratio of stress to strain.
- ( ) The ratio of shear stress to shear strain.

Q2. What are the stresses acting on a plane that is inclined to the direction of the applied stress? **1 1 1**

- ( ) Only normal stress
- ( ) Only shear stress
- (•) Both normal and shear stress
- ( ) Neither normal nor shear stress

Q3. What is the relationship between bending stress and the distance from the neutral axis? **1 2 1**

- ( ) Bending stress is constant
- (•) Bending stress is directly proportional to the distance from the neutral axis
- ( ) Bending stress is inversely proportional to the distance from the neutral axis
- ( ) Bending stress is independent of the distance from the neutral axis

Q4. What is the internal resistance to sliding along a plane in a beam called? **1 2 1**

- (•) Shear force
- ( ) Bending moment
- ( ) Axial force
- ( ) Torsional moment

Q5. What is the relationship between the angle of twist (θ), torque (T), length (L), modulus of rigidity (G), and polar moment of inertia (J) in a solid circular shaft? **1 3 1**

- (•) θ = (T * L) / (G * J)
- ( ) θ = (G * J)/ (T * L)
- ( ) θ = (T * G)/ (L * J)
- ( ) θ = (J * L)/ (T * G)

Q6. What is the primary stress state induced in a carriage spring subjected to an axial load? **1 3 1**

- ( ) Normal stress
- ( ) Shear stress
- (•) Bending stress
- ( ) Both shear and bending stress

Q7. The Macaulay's method is based on which concept? **1 4 1**

- ( ) Area moment theorem
- (•) Superposition principle
- ( ) Dirac delta function
- ( ) Unit load method

Q8. In the conjugate beam method, the length of the conjugate beam is: **1 4 1**

- (•) Equal to the actual beam
- ( ) Twice the actual beam
- ( ) Half the actual beam
- ( ) Depends on the support conditions

Q9. In a thin cylindrical shell subjected to internal pressure, the hoop (circumferential) stress acts: **1 5 1**

- ( ) Along the axis of the cylinder
- (•) Along the circumference of the cylinder
- ( ) Radially outward
- ( ) None of the above

Q10. The radial stress at the outer surface of a thick-walled cylinder subjected to internal pressure only is: **1 5 1**

- ○ Equal to internal pressure
- ◉ Zero
- ○ Half of the internal pressure
- ○ Equal to the hoop stress

Section 2 (Answer all question(s))

Marks CO BL

Q11. A circular rod of diameter 16 mm and 500 mm long is subjected to a tensile force 40kN. The modulus of elasticity for steel may be taken as 200kN/mm^2. Find stress, strain and elongation of the bar due to applied load. **3 1 2**

Rubric	Marks
Calculate stress	1
Calculate strain	1
Calculate elongation of the bar	1

Q12. (a) A bar of brass 20 mm is enclosed in a steel tube of 40 mm external diameter and 20 mm internal diameter. The bar and the tubes are initially 1.2 m long and are rigidly fastened at both ends using 20 mm diameter pins. If the temperature is raised by 60°C, find the stresses induced in the bar, tube and pins. **7 1 3**

Rubric	Marks
Draw diagram - 1 mark	1
Calculate stress in steel - 2 marks	2
Calculate stress in brass - 2 marks	2
Shear stress in pin - 2 marks	2

(OR)

(b) An elemental cube is subjected to tensile stresses of 30 N/mm² and 10 N/mm² acting on two mutually perpendicular planes and a shear stress of 10 N/mm² on these planes. Draw the Mohr's circle of stresses and hence or otherwise determine the magnitudes and directions of principal stresses and also the maximum shear stress.

Rubric	Marks
Explain and draw Mohr's circle - 4 marks	4
Calculate principal stresses - 2 marks	2
Calculate maximum shear stress. - 1 marks	1

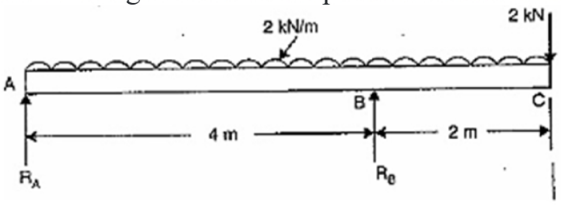
Section 3 (Answer all question(s))

Marks CO BL

Q13. Define and explain the following terms: **3 2 2**
(i) Shear force
(ii) Bending moment
(iii) Bending moment diagram.

Rubric	Marks
Explain Shear force - 1 mark	1
Explain bending moment - 1 mark	1
Explain bending moment diagram - 1 mark	1

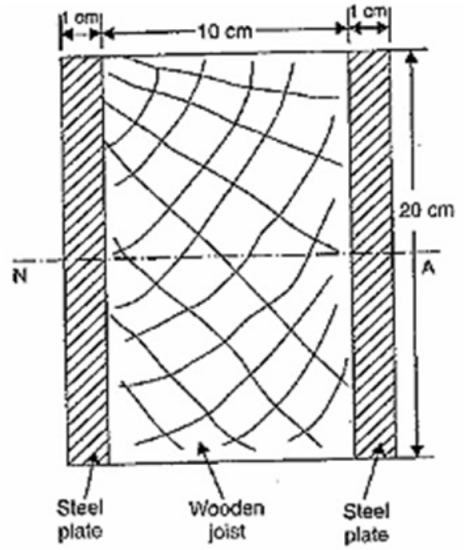
Q14. (a) Draw the S.F. (Shear Force) and B.M. (Bending Moment) diagrams for the overhanging beam carrying a uniformly distributed load of 2 kN/m over the entire length and a point load of 2 kN as shown in figure. Locate the point of contraflexure. **7 2 1**



Rubric	Marks
Calculate reaction at support - 1 mark	1
Calculate Shear force at different point and draw SFD - 3 mark	3
Calculate Bending Moment at different point and draw BMD - 3 mark	3

(OR)

(b) A flitched beam consists of a wooden joist 10 cm wide and 20 cm deep strengthened by two steel plates 10 mm thick and 20 cm deep as shown in figure. If the maximum stress in the wooden joist is 7 N/mm², find the corresponding maximum stress attained in steel. Find also the moment of resistance of the composite section. Take Young's modulus for steel = 2×10^5 N/mm² and for wood = 1×10^4 N/mm².



Rubric	Marks
Calculate Moment of Inertia of wooden joist - 1 mark	1
Calculate Moment of Inertia of two steel plate - 1 mark	1
Calculate modular ratio - 1 marks	1
Calculate equivalent Moment of Inertia - 1 mark	1
Calculate moment of resistance of composite section -1 mark	1
Calculate maximum stress in wooden joist and steel plate - 2 marks	2

Section 4 (Answer all question(s)) **Marks CO BL**

Q15. Define the terms: **3 3 1**
(i) Torsion
(ii) Torsional Rigidity
(iii) Polar moment of inertia

Rubric	Marks
Define Torsion	1
Define Torsional Rigidity	1
Define Polar moment of inertia	1

Q16. (a) A solid cylindrical shaft is to transmit 300 kW power at 100 r.p.m. **7 3 4**
(i) If the shear stress is not to exceed 80 N/mm^2, finds its diameter.
(ii) What percent saving of weight would be obtained if this shaft is replaced by a hollow on whose internal diameter equals to 0.6 of the external diameter, the length, the material and maximum shear stress being the same?

Rubric	Marks
Calculate Torsion	1
Calculate Diameter of shaft	1
Calculate outer and inner diameter of shaft	3
Calculate percentage saving in weight	2

(OR)

(b) A closely coiled helical spring made of 10 mm diameter steel wire has 15 coils of 100 mm mean diameter. The spring is subjected to an axial load of 100 N. Calculate:
(i) The maximum shear stress induced,
(ii) The deflection, and
(iii) Stiffness of the spring.
Take modulus of rigidity, C = 8.16×10^4 N/mm^2.

Rubric	Marks
Calculate maximum shear stress	2
Calculate deflection	3
Calculate stiffness of the spring	2

Section 5 (Answer all question(s))

Marks CO BL

Q17. (i) Define Mohr's theorems. **4 4 2**
(ii) Define conjugate beam.

Rubric	Marks
Define Mohr's theorems.	2
Define conjugate beam	2

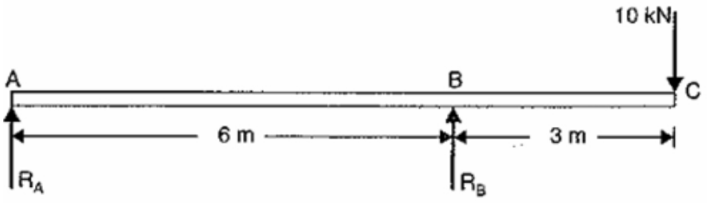
Q18. (a) Determine: **6 4 4**

(i) Slope at the left support,
(ii) Deflection under the load, and
(iii) Maximum deflection of a simply supported beam of length 5 m, which is carrying a point load of 5 kN at a distance of 3 m from the left end.
Take $E = 2 \times 10^5$ N/mm² and $I = 1 \times 10^8$ mm⁴.

Rubric	Marks
Calculate Slope at the left support	2
Calculate Deflection under the load	2
Calculate Maximum deflection	2

(OR)

(b) An overhanging beam ABC is loaded as shown in figure. Find the slopes over each support and at the right end. Find also the maximum upward deflection between the supports and the deflection at the right end. (Use Moment area method)
Take $E = 1X10^5$ N/mm^2 and $I = 5X10^8$ mm^4



Rubric	Marks
Calculate Slope slopes over each support and at the right end	3
Calculate maximum upward deflection between the supports and the deflection at the right end	3

Section 6 (Answer any 2 question(s))

Marks CO BL

Q19. Derive the expressions for hoop stress and longitudinal stress in a thin cylinder with ends closed by rigid flanges and subjected to an internal fluid pressure p. Take the internal diameter and shell thickness of the cylinder to be 'd' and 't' respectively. **5 5 3**

Rubric	Marks
Neat and clean diagram	2
derivation of hoop and longitudinal stress	3

Q20. A spherical shell of internal diameter 0.9 m and of thickness 10 mm is subjected to an internal pressure of 1.4 N/mm². Determine the increase in diameter and increase in volume. Take $E = 2 \times 10^5$ N/mm² and $\mu = 1/3$. **5 5 1**

Rubric	Marks
Calculate increase in diameter	2
Calculate increase in volume	3

Q21. What do you mean by Lame's equations? How will you derive these equations? **5 5 1**

Rubric	Marks
Expalin Lame's equation.	1
Derive equation	4

******