**2022 SCHEME**

*Basavarajeswari Group of Institutions*

# BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

**USN** | | | | | | | | | | |  **Course Code** | 2 | 2 | C | V | 3 | 4 |

Third Semester B.E. Degree Examinations, January 2025

## STRENGTH OF MATERIALS

**Duration: 3 hrs** **Max. Marks: 100**

***Note:* *1. Answer any* FIVE *full questions choosing ONE full Question from each Module.***
***2. Missing data, if any, may be suitably assumed***

| Q. No | | Question | Marks | (RBTL:CO:PI) |
|---|---|---|---|---|
| | | **Module-1** | | |
| **1.** | **a.** | Derive an expression for elongation of circular tapering bar subjected to an axial pull P. | **08** | **(1:1:1.3.1)** |
| | **b.** | The tensile test was conducted on mild steel bar. The following data was obtained from the test. (i) Diameter of the bar =16 mm (ii) gauge length of the bar=80 mm (iii) Load at proportionality limit=72 kN (iv) Extension at a load of 60 kN=0.115 mm (v) Load at failure =80 kN (vi) Final Gauge length of the bar=104 mm (vii) diameter at failure=12 mm. Determine (i) Young's modulus (ii) Proportionality Limit (iii) True Breaking stress (iv) Percentage elongation. | **12** | **(2:1:1.3.1)** |
| | | **(OR)** | | |
| **2.** | **a.** | Derive the relation between young's modulus and shear modulus with usual notations | **10** | **(1:1:1.3.1)** |
| | **b.** | A load of 600kN is applied on a reinforced concrete column of size 300 mm x 500 mm. The column is reinforced with 6 number of steel bars of diameter 10 mm find the stress developed in steel and concrete. Take $E_S = 15E_S$ | **10** | **(2:1:1.3.1)** |
| | | **Module-2** | | |
| **3.** | **a.** | Demonstrate shear force and bending moment in beams. Also state the engineering significance of the same. | **08** | **(1:2:1.3.1)** |
| | **b.** | Draw SF and BM diagrams indicating principal values for a simply supported beam loaded as shown in Fig. Q3(b). Locate the point of contra-flexure if any | **12** | **(2:2:1.3.1)** |

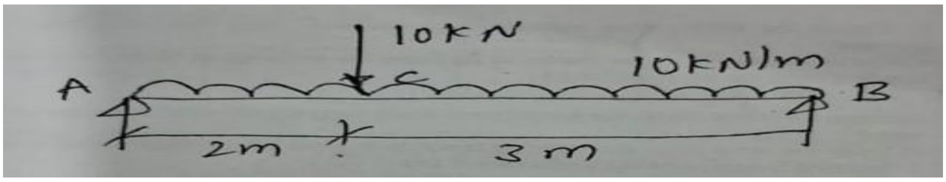


**Fig. Q3(b)**

**(OR)**

| | | | | |
|---|---|---|---|---|
| **4.** | **a.** | Derive the relationship between load intensity, shear force and bending moment. | **08** | **(1:2:1.3.1)** |

**Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI– Performance Indicator)**

| | | | | |
|---|---|---|---|---|
| | **b.** | Draw the shear force and bending moment diagram for the beam shown in Fig. Q4 (b) locating the point of contra-flexure if any. | **12** | **(2:2:1.3.1)** |

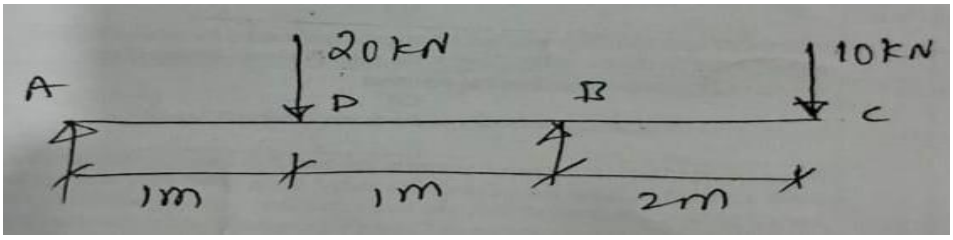


**Fig. Q4(b)**

## Module-3

| | | | | |
|---|---|---|---|---|
| **5.** | **a.** | Draw the shear stress diagram for a rectangular beam section and show that maximum shear stress is 1.5 times average shear stress. | **08** | **(1:3:1.3.1)** |
| | **b.** | A T-section as shown in Fig. Q 5(b) has a flange of 120 mm × 12 mm and overall depth 200 mm, with web 12 mm thick is loaded such that, at a section it has a moment of 20 kN-m and shear force of 120 kN. Sketch the bending and shear stress distribution diagram, marking the salient values. | **12** | **(2:3:1.3.1)** |

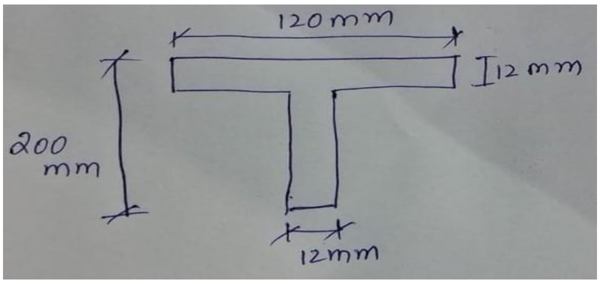


**Fig. Q 5 (b)**

**(OR)**

| | | | | |
|---|---|---|---|---|
| **6.** | **a.** | Derive Bernoulli-Euler bending equation. | **10** | **(1:3:1.3.1)** |
| | **b.** | A cantilever of square section 200 mm × 200 mm, 2 m long just fails in flexure when a load of 12 kN is placed at its free end. A beam of the same material and having rectangular cross section 150 mm × 300 mm is simply supported over span of 3m. Calculate the minimum Central concentrated load required to break the beam. | **10** | **(2:3:1.3.1)** |

## Module-4

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|---|---|---|---|---|
| **7.** | **a.** | Derive an expression of normal stress and tangential stress for two dimensional stress system. | **08** | **(1:4:1.3.1)** |
| | **b.** | For the system shown in Fig. Q7(b) determine: | **12** | **(2:4:1.3.1)** |

(i) The normal and tangential stress intensities.
(ii) Magnitude and direction of resultant stress.
(iii) Maximum shear stress.

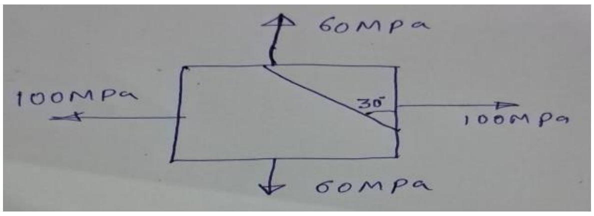


**Fig. Q7(b)**

**Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI– Performance Indicator)**

**(OR)**

| | | | | |
|---|---|---|---|---|
| **8.** | **a.** | Derive the torsion equation $\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{L}$ with usual notations. | **10** | **(1:4:1.3.1)** |
| | **b.** | A solid shaft is to transit 1000 kW at 120 rpm. If the shear stress of the material should not exceed 80 MPa and maximum torque being 25% more than the mean, find the diameter required. What percentage saving in weight would be obtained if this shaft is replaced by a hollow one whose $d_i$=0.6$d_o$, the length, material and shear stress remaining same. | **10** | **(2:4:1.3.1)** |

**Module-5**

| | | | | |
|---|---|---|---|---|
| **9.** | **a.** | Derive an expression for the critical load in a column subjected to compressive load, when both end are pinned. | **08** | **(1:5:1.3.1)** |
| | **b.** | A 1.5 m long column has a circular cross section of 50 mm diameter. One end of the column is fixed and the other end is free. Taking the factor of safety as 3, calculate the safe load using:<br>(i) Rankine's formula taking yield stress 560 N/mm$^2$ and α = 1/1600.<br>(ii) Euler's formulas taking E = 1.2 × 10$^5$ N/mm$^2$. | **12** | **(2:5:1.3.1)** |

**(OR)**

| | | | | |
|---|---|---|---|---|
| **10** | **a.** | Derive moment curvature equation of deflection. | **08** | **(1:5:1.3.1)** |
| | **b.** | A simple supported beam 8 m long carries two concentrated loads of 80 kN and 60 kN a distance of 3 m and 6 m from left end support respectively. Calculate the slope and deflection under loads. Given E=200 GPa and I = 300 ×10$^6$ mm$^4$. | **12** | **(2:5:1.3.1)** |

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**Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI– Performance Indicator)**