*Basavarajeswari Group of Institutions*

# BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

| USN | | | | | | | | | | Course Code | 2 | 2 | M | E | 3 | 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

Third Semester B.E. Degree Examinations, March/April 2024

## MECHANICS 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.** | Define (i) Stress (ii) Strain (iii) Poison's ratio (iv) Hooke's Law (v) Factor of safety (vi) Young's Modulus | **12** | (2 :1 : 1.4.1) |
| | **b.** | A steel bar of cross-section area 200 $mm^2$ is loaded as shown in Fig. Q1(b) Find the change in length of the bar. Take E = 200 GPa. | **08** | (2 :1 : 2.2.3) |

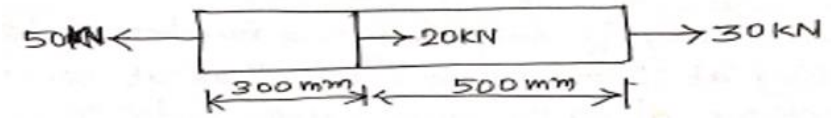


**Fig. Q1(b)**

**OR**

| | | | | |
|---|---|---|---|---|
| **2.** | **a.** | Derive an expression for the deformation of a tapered rectangular bar subjected to a tensile load. | **10** | (2 :1 : 1.4.1) |
| | **b.** | Derive the relationship between E, G and K. | **10** | (2 :1 : 1.4.1) |
| | | **Module-2** | | |
| **3.** | **a.** | Define and explain briefly principal stress and principal strain | **08** | (2 :2 : 1.3.1) |
| | **b.** | Derive the expressions for change in diameter, length and volumetric strain of thin cylinder due to the effect of internal pressure? | **12** | (2 :2 : 1.4.1) |
| | | **OR** | | |
| **4.** | **a.** | Derive the expression for longitudinal stress in case of thin cylinder? | **06** | (2 :2 : 1.4.1) |
| | **b.** | Distinguish between thin and thick cylinders. | **04** | (2 :2 : 1.3.1) |
| | **c.** | A shell 3.25 m long and 1 m diameter, is subjected to an internal pressure of 1.2 $N/mm^2$. If the thickness of the shell is 10 mm. Find the circumferential and longitudinal stresses. Also, find the maximum shear stress and changes in dimensions of the shell. Take E = 200 $kN/mm^2$ and Poisson's ratio = 0.3. | **10** | (2 :2 : 2.2.3) |
| | | **Module-3** | | |
| **5.** | **a.** | Derive the relationship between load, shear force and bending moment. | **08** | (2 :3 : 1.3.1) |
| | **b.** | A cantilever beam carries point loads and UDL as shown in Fig. Q5 (b). Draw the shear force and bending moment diagram. | **12** | (2 :3 : 2.2.3) |

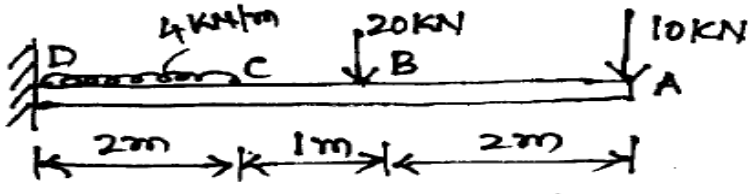


**Fig. Q5 (b)**

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

**OR**

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| **6.** | **a.** | List the assumptions of stress in beams | **05** | (2 :3 : 1.3.1) |
| | **b.** | Derive an expression for deformation of an infinite beam element and resultant moments about x, y and z axis along with flexural formula. | **15** | (2 :3 : 1.4.1) |

**Module-4**

| | | | | |
|---|---|---|---|---|
| **7.** | **a.** | Derive an expression for differential equation of elastic curve | **10** | (2 :4 : 1.4.1) |
| | **b.** | The cantilever beam AB of length L shown in Fig. Q7 (b), carries a uniformly distributed load of intensity $w_0$, which includes the weight of the beam. (i) Derive the equation of the elastic curve (ii) Compute the maximum displacement if the beam is a W12 x 35 section using L= ¼ 8 ft, $w_0$ = 400 lb/ft and E = 29 × $10^6$ psi. | **10** | (2 :4 : 2.2.3) |

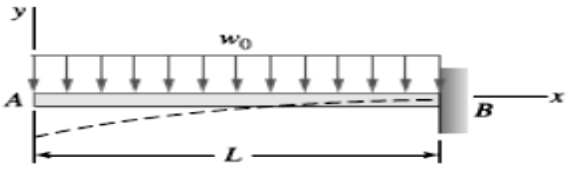


**Fig. Q7 (b)**

**OR**

| | | | | |
|---|---|---|---|---|
| **8.** | **a.** | Derive the torsional formula in the standard form $\frac{T}{J}=\frac{\tau}{r}=\frac{C\theta}{L}$ | **10** | (2 :4 : 1.4.1) |
| | **b.** | A hollow shaft is to transmit 300 kW power at 80 rpm. If the shear stress is not to exceed 60 N/mm$^2$ and internal diameter is 0.6 times the external diameter. Find the external and internal diameter assuming that maximum torque is 1.4 times the mean torque. | **10** | (2 :4 : 2.2.3) |

**Module-5**

| | | | | |
|---|---|---|---|---|
| **9.** | **a.** | Derive an expression for crippling load, both ends of the column are hinged. | **10** | (2 :5 : 1.4.1) |
| | **b.** | A column of section 15 cm × 20 cm is 6 m long, whose both ends are fixed. If the young's modulus is 17.5 kN/mm$^2$ then determine (i) crippling load (ii) safe load for the column if factor of safety is 3. | **10** | (2 :5 : 2.2.3) |

**OR**

| | | | | |
|---|---|---|---|---|
| **10** | **a.** | Define (i) strain energy (ii) Modulus of resilience (iii) Castigliano's theorem I (iv) Toughness (v) Castigliano's theorem II | **10** | (2 :5 : 1.4.1) |
| | **b.** | Derive and expression for strain energy due to shear stress. | **10** | (2 :5 : 1.4.1) |

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