INSTITUTE OF TECHNOLOGY BANGALORE Library Date

CBCS SCHEME

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17AU34

Third Semester B.E. Degree Examination, July/August 2021
Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

1 a. Define : i) Proof stress ii) Proportionality limit iii) Hook's law iv) Poisson's ratio. **(04 Marks)**

b. Derive an expression for the total elongation of the tapered bar varying diameter from d_1 to d_2 when subjected to axial load P. **(08 Marks)**

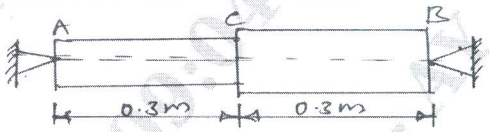
c. A brass bar having uniform cross sectional area of $300mm^2$ is subjected to a load as shown in Fig. Q1(c). Find the total elongation of bar and magnitude of load 'P' if Young's modulus is 83GPa. **(08 Marks)**

Fig.Q1(c)

2 a. Establish relationship between Young's modulus, Rigidity modulus and Bulk modulus. **(10 Marks)**

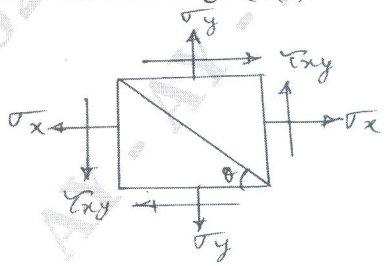
b. Calculate the values of the the stress and strain in portion AC and CB of the steel bar shown in Fig. Q2(b). A close fit exist at both the rigid support at room temperature and the temperature is raised by 75^0C. Take E = 200GPa and $\alpha = 12 \times 10^{-6}$ / ^{0}C for steel. Area of cross section of AC is $400mm^2$ and of BC is $800mm^2$. **(10 Marks)**

Fig.Q2(b)



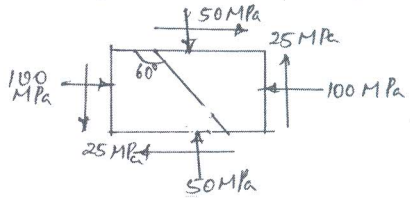
3 a. Derive the expression for normal stress and shear stress on a plane inclined at 'θ' to vertical axis in a general stress system as shown in Fig. Q3(a). **(10 Marks)**

Fig.Q3(a)



b. A machine component is subjected to the stresses as shown in Fig. Q3(b). Find the normal and shear stresses on the section AB inclined at an angle 60^0 with x – x axis. Also find the resultant stress on the section. Verify the above results by drawing Mohr's circle. **(10 Marks)**

Fig.Q3(b)



4 a. What is Thin and Thick cylinders? Explain with examples. **(04 Marks)**

b. A thin cylinder 3m long is having 1m diameter and 15mm thickness. Calculate the maximum intensity of shear stress induced and also changes in the dimensions of the cylinder if it is subjected to an internal pressure of 1.5 N/mm^2. **(08 Marks)**

c. A thick cylindrical vessel is 250mm internal diameter and has 50mm thick wall. It is subjected to an internal pressure of 10MPa, due to the movement of the fluid. Find the maximum hoop stress developed in the cylinder. Also calculate the radial and hoop stresses at a point 22mm from the inner surface. Sketch the stresses. **(08 Marks)**

5 a. Define a Beam. Explain the simple sketches, different types of beams. **(06 Marks)**

b. Draw the shear force and bending moment diagrams for the overhanging beam carrying uniform distributed load of 2 kN/m over the entire length and a point load 2 kN as shown in Fig Q5(b). Locate the point of contra flexure. **(14 Marks)**

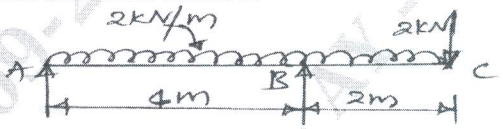


Fig.Q5(b)

6 a. A cantilever of square section 200mm × 200mm, 2mm long just fails in flexure when a load of 12kN is placed at its free end. A beam of the same material and having a rectangular cross section 150mm wide and 300mm deep is simply supported over a span of 3m. Calculate the minimum control point load required to break the beam. **(10 Marks)**

b. Derive an expression with usual notations for the maximum deflection in simply supported beam subjected to point load (N) at mid span. **(10 Marks)**

7 a. Derive the torsion formula in the standard form $\frac{T}{J} = \frac{G\theta}{\ell} = \frac{\tau}{r}$ and list all the assumptions. **(10 Marks)**

b. A solid shaft transmits 30kW at 500 rpm. Maximum torque is 20% more than mean Torque. Allowable shear stress 65MPa and modulus of rigidity 81GPa. Angle of twist is 1^0 in 1 meter length. Determine suitable diameter. **(10 Marks)**

8 a. Derive an expression for Euler's critical load for a column with ends pinned (hinged). **(10 Marks)**

b. A solid rod of 60mm diameter and 2.5m is used as a struct. Find the safe compressive load for the struct. i) Both ends are hinged ii) Both ends are fixed. Take $E = 2 \times 10^5 N/mm^2$ and factor of safety = 3. **(10 Marks)**

9 a. Derive an expression for strain energy for a member subjected to axial load. **(05 Marks)**

b. Explain Castigliano's theorem - I. **(05 Marks)**

c. A round rod 120mm diameter, 1.8m long transmit 300kW at 900 rpm. Find the maximum strain energy stored by the rod. Take G = 80000 N/mm^2. **(10 Marks)**

10 a. Explain Maximum Principal Stress theory and Maximum Shear Stress theory of failure. **(08 Marks)**

b. A bolt is subjected to an axial pull of 12kN together with a transverse shear of 6kN. Determine the diameter of the bolt according to

i) Maximum Principal Stress theory ii) Maximum Shear Stress theory.

Take $\tau_{yt} = 300 N/mm^2$; FOS = 3 ; Poisson's ratio = 0.3. **(12 Marks)**

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