

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Special), January/February 2016

B. Tech/ B. Tech. + MBA in Mechanical Engineering, Semester III

Roll No.....

ME306: STRENGTH OF MATERIALS

Time: 3 hours

Max. Marks: 100

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1A Objective, one or two line answers type questions (1 mark each)

10

- i. A block of steel is loaded by a tangential force on its top surface while the bottom surface is held rigidly (Fig.1). The deformation of the block is due to
(a) shear only (b) bending only (c) shear and bending
(d) torsion

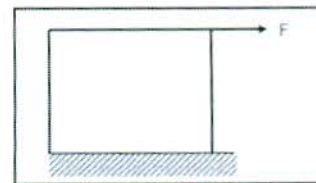


Fig. 1.

- ii. What is polar modulus? Give the expressions for polar modulus for a solid shaft
- iii. Maximum principal stress is equal to
(a) $(\sigma_x + \sigma_y)/2 + [(\sigma_x - \sigma_y)^2 + \tau^2]^{0.5}$, (b) $(\sigma_x + \sigma_y)/2 + 0.5 [(\sigma_x - \sigma_y)^2 + \tau^2]^{0.5}$
(c) $(\sigma_x + \sigma_y)/2 + 0.5 [(\sigma_x - \sigma_y)^2 + 4\tau^2]^{0.5}$, (d) None
- iv. What are the different types of loads acting on a beam?
- v. Give the relations between Young's modulus and Bulk modulus
- vi. Give the relations between load, shear force and bending moment.
- vii. What is meant by the stiffness of a spring?
- viii. Name the stresses setup in a thin cylinder subjected internal fluid pressure
- ix. A shaft turns at 150 rpm under a torque of 1500 N-m. Power transmitted is
a) 15π kW b) 10π kW c) 7.5π kW d) 5π kW
- x. Define thin cylinders.

Q.2 Write short answer type questions (2.5 marks each)

10

- a) Define the terms: principal planes and principal stresses.
- b) Determine the maximum permissible load on a steel bar of 20 mm diameter when the factor of safety is 1.8 and the ultimate stress is 495 MPa
- c) Draw a Mohr's circle for pure shear stress of 50 N/mm² at a point

d) Calculate the maximum torque that a shaft of 125 mm diameter can transmit, if the maximum angle of twist is 1° in a length of 1.5 m. take $G = 70 \times 10^3 \text{ N/mm}^2$

Q.3A Draw the stress strain curve for mild steel (MS) subjected to tension and indicate the salient points. 05

Q.3B Derive the relation between Pressure, Diameter and Thickness of the cylinder for hoop and longitudinal stress in the case of thin cylinder. 05

Q.4A A mild steel bar of cross-sectional area 490 mm^2 is surrounded by a copper tube of area 210 mm^2 as shown in Fig. 2. When they are placed centrally over a rigid base, it is found that the steel bar is 0.15 mm longer. Over this unit, a rigid plate carrying a load of 80 kN is placed. Find the stresses in each bar if the length of the composite bar is 1 m . $E_s = 200 \text{ GN/m}^2$ and $E_c = 104.7 \text{ GN/m}^2$.

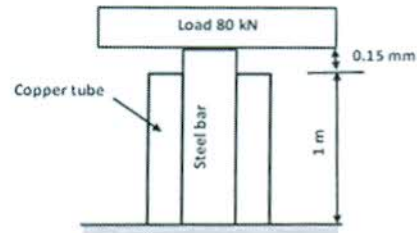


Fig. 2.

(i)
Q.4B A solid circular shaft of 10 cm diameter of length 4 m is transmitting 112.5 kW power at 150 rpm . Determine the maximum shear stress induced in the shaft. Take $G = 8 \times 10^4 \text{ N/mm}^2$. 05

Q.5A A torque T is applied at the free end of a stepped rod of circular cross-sections as shown in the figure 3. The shear modulus of the material of the rod is G . Find out the expression for d to produce an angular twist θ at the free end. 5

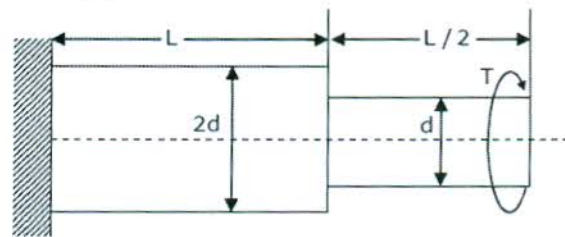


Figure 3

Q.5B A leaf spring is required to satisfy the following specification. $L = 0.75 \text{ m}$, $W = 5 \text{ kN}$, $b = 75 \text{ mm}$, maximum stress 210 MN/m^2 , maximum deflection 25 mm , $E = 200 \text{ GN/m}^2$. Find the number of leaves and their thickness. If the leaves become straight when the load is applied, find the initial radius of curvature. 05

Q.6A For a simply supported overhanging beam loaded as shown in fig. 4, find the reactions and draw the bending moment and shearing force diagrams. Locate the point of contraflexure if any. 10

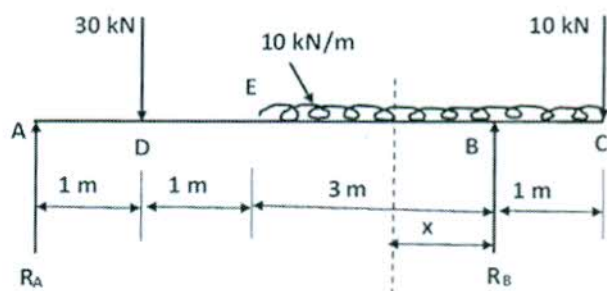


Fig. 4.

OR

- Q.6B (a) A beam of uniform rectangular section 200 mm wide and 300 mm deep is simply supported at its ends. It carries a uniformly distributed load of 9 kN/m run over the entire span of 5 m. If the value of E for the beam material is 1×10^4 N/mm², find (i) the slope at the supports and (ii) maximum deflection. 5 + 5
- (b) A cantilever of length 4 m carries a uniformly varying load of zero intensity at the free end, and 50 kN/m at the fixed end. If $E = 2 \times 10^5$ N/mm² and $I = 10^8$ mm⁴, find the slope and deflection at the free end.
- Q.7A Derive an expression for the crippling load of a long column when both ends are hinged 05
- Q.7B Derive an expression for the slope and deflection of a cantilever of length L , carrying a point load W at the free end by moment area method. 05
- OR**
- Q.7C A 1.5 m long column has a circular cross-section of 5 cm diameter. One of the ends of the column is fixed in direction and the other end is free. Taking factor of safety as 3. Calculate the safe load using Rankine's formula, take yield stress = 560 N/mm² and Rankine's constant $\alpha = 1/1600$ 05
- Q.8 Derive the relation between elastic constants (E , G , k and μ) 10
- Q.9A 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: (a) Maximum shear stress (b) The deflection and (c) Stiffness of the spring. Take modulus of rigidity, $G = 8.16 \times 10^4$ N/mm² 10
- Q.9B A point in a strained material is subjected to stresses shown in Figure 5. Using Mohr's circle method determine the normal and tangential stresses across the oblique plane. Check the answers analytically. 10

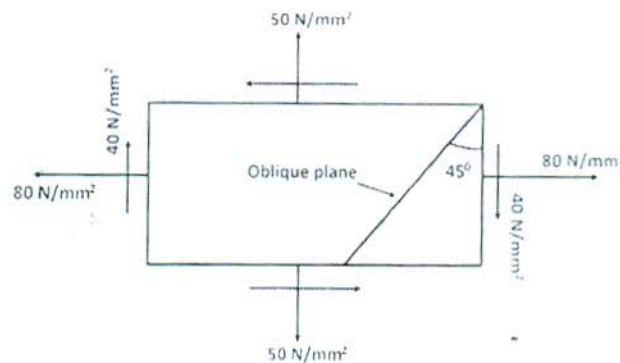


Fig. 5.