

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination, November-December 2015

B. Tech/ B. Tech. 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.
4. Exchange of calculator not permitted

Q.1A Objective, one or two line answers type questions (1 mark each) 10

- i. Whenever a material is loaded within elastic limit, stress is _____ strain.
- ii. If the young's modulus of elasticity of a material is twice its modulus of rigidity, then the Poisson's ratio of the material is
a)-1 b)-0.5 c) 0.5 d) 0
- iii. Give the relations between Young's modulus and Bulk modulus
- iv. 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
- v. Maximum bending moment in a beam occurs where
a) deflection is zero b) shear force is maximum c) shear force is minimum
d) shear force changes sign
- vi. If the length of a simply supported beam carrying a concentrated load at the center is doubled, the deflection at the center will become
a) two times b) four times c) Eight times d) sixteen times
- vii. 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
- viii. Name the stresses setup in a thin cylinder subjected internal fluid pressure
- ix. Maximum bending stress in a leaf spring is
(a) $3WL/4nbt^2$, (b) $3WL/8nbt^2$, (c) $3WL/2nbt^2$, (d) None
- x. Shear stress in a close coiled helical spring is
(a) $16WD/\pi d^3$ (b) $32WD/\pi d^3$ (c) $8WD/\pi d^3$ (d) None

Q.2 Write short answer type questions (2.5 marks each) 10

- a) Draw stress strain curve for mild steel and depict silent points on it
- 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) Explain different types of loads applied on beams
- d) Explain Euler's curve

- Q.3A A bar of uniform thickness and length L has its depth increasing from ' d ' at one end to ' D ' at the other. Determine the elongation of the member subjected to a tensile force P . 05
- Q.3B A rectangular block that is 350 mm long, 100 mm wide and 80 mm thick is subjected to axial loads of 50 kN tensile force in the direction of length, 100 kN compressive force in the direction of its thickness and 60 kN tensile force in the direction of its width. Determine change in the volume, bulk modulus and modulus of rigidity. Take $E = 2 \times 10^5 \text{ N/mm}^2$ and poisson's ratio $= 0.25$. 05
- Q.4A 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.4B Prove that a hollow shaft is stronger and stiffer than a solid shaft of the same material, length and weight. 05
- Q.5A A beam of span $2L$ simply supported at the ends carries at the two loads W each symmetrically placed at a distance $L/3$ on either side of the mid-span. Find the maximum deflection. 5
- Q.5B An 80 mm wide and 180 mm deep cantilever is of 3 m span. It carries a uniformly distributed load of 6 kN/m intensity on a 2 m length of the span starting from the free end. Determine the slope and deflection at the free end. Take $E = 205 \text{ GPa}$ 5
- Q.6A Derive an expression for the crippling load of a long column when both ends are hinged 5
- Q.6B A cast iron column with a 10 cm external diameter and 8 cm internal diameter is 3 m long. Calculate the safe load using Rankine's formula, if both ends are fixed. Take $\sigma_c = 600 \text{ N/mm}^2$ and $\alpha = 1/1600$. Adopt a factor of safety of 3. 5
- Q.7A A truck weighing 30 kN and moving at 6 km/hour has to be brought to rest by a buffer. How many springs, each of 20 coils, will be required to store the energy of motion during a compression of 200 mm? The spring is made out of a 20 mm diameter steel rod coiled to a mean diameter of 200 mm. Take modulus of rigidity, $G = 100 \text{ GN/m}^2$ 05
- Q.7B 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.8 A rod is composed of three segments as shown in fig. 1. The rod is held between rigid supports. Find the stress developed in each material when the temperature of the system is raised by 50°C under the following two different conditions. 10
 (a) When the supports are perfectly rigid and (b) When the right hand support yields by 0.2 mm. $E_{\text{steel}} = 200 \text{ GN/m}^2$, $\alpha_{\text{steel}} = 1.2 \times 10^{-5}/^\circ\text{C}$, $E_{\text{copper}} = 100 \text{ GN/m}^2$, $\alpha_{\text{copper}} = 1.8 \times 10^{-5}/^\circ\text{C}$ $E_{\text{aluminium}} = 200 \text{ GN/m}^2$, $\alpha_{\text{aluminium}} = 1.2 \times 10^{-5}/^\circ\text{C}$

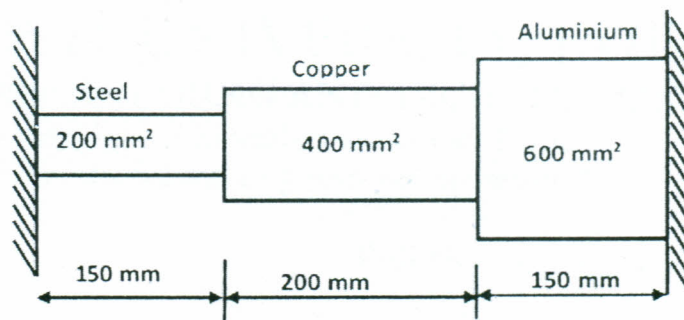


Fig. 1.

Q.9A For a simply supported overhanging beam loaded as shown in fig. 2, find the reactions and draw the bending moment and shearing force diagrams. Locate the point of contraflexure if any.

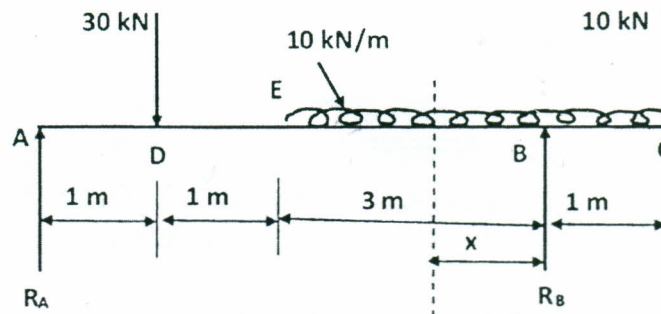


Fig. 2.

Q.9B An element has a tensile stress of 600 MN/m^2 and a compressive stress of 400 MN/m^2 acting on two mutually perpendicular planes. It has two equal shear stresses of 200 MN/m^2 on these planes (Fig. 3). Determine the magnitude and direction of the (i) principal stresses and (ii) maximum shear stress using analytical method.

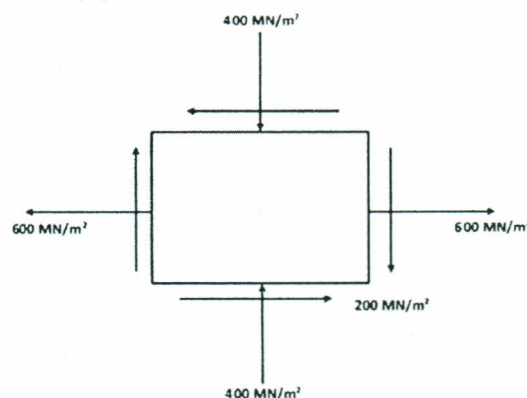


Fig. 3.

OR

Q.9B An element has a tensile stress of 600 MN/m^2 and a compressive stress of 400 MN/m^2 acting on two mutually perpendicular planes. It has two equal shear stresses of 200 MN/m^2 on these planes. Determine the magnitude and direction of the (i) principal stresses and (ii) maximum shear stress using Mohr's circle (Graphical) method.