

B.E. (CE) Part-II 4th Semester Examination, 2006

Strength of Materials I
(AM-401)

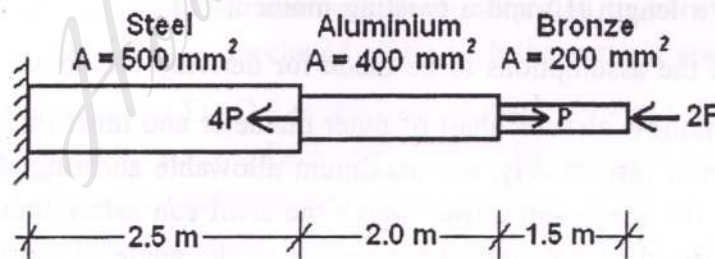
Time : 3 hours

Full Marks : 100

Use separate answerscript for each half.
Answer SIX questions, taking THREE from each half.
The questions are of equal value.
Two marks are reserved for neatness in each half.
Assume suitable data wherever missing.

FIRST HALF

1. An aluminium rod is rigidly attached between a steel rod and a bronze rod as shown in Fig.Q.1. The cross-sectional areas of steel, aluminium and bronze rods are 500 mm^2 , 400 mm^2 and 200 mm^2 respectively. Length of each position is shown in the figure. The compound bar is subjected to axial forces as shown. Find the maximum value of P, that will not exceed a stress in steel of 140 MPa, in aluminium of 90 MPa or in bronze of 100 MPa, and also the total change of length of the compound bar will not exceed 3.65 mm. Assume $E_{\text{steel}} = 200 \text{ GPa}$, $E_{\text{aluminium}} = 70 \text{ GPa}$ and $E_{\text{bronze}} = 83 \text{ GPa}$.



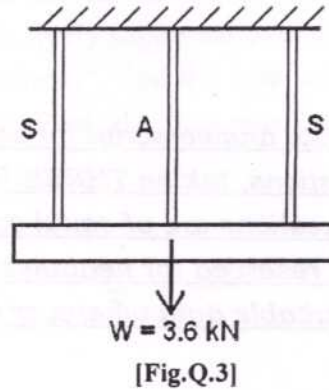
[Fig.Q.1]

2. a) Define modulus of elasticity (E), modulus of rigidity (G) and Poisson's ratio (μ) of an elastic material.
b) Derive a relationship between E and G.
3. A rigid bar weighing 3.6 kN hangs from ceiling with three equally spaced wires, two of steel (marked as S) and one of aluminium (marked as A) as shown in figure Q.3. The diameter of the wires are 3 mm. Before they were loaded all the three wires had the same length.

(AM-401)

What temperature increase ΔT in all the three wires would results in the entire load being carried by the steel wires only?

Assume : $E_s = 2 \times 10^5 \text{ N/mm}^2$, $\alpha_s = 12 \times 10^{-6}/^\circ\text{C}$ and $\alpha_a = 23 \times 10^{-6}/^\circ\text{C}$.



4. a) A thinwalled (thickness t) closed conical vessel of height h and apex angle 2α , is filled with a gas at a pressure p . Find the expression for the principal membrane stresses at a point on the wall, at a depth Y below the apex.

b) The maximum instantaneous elongation produced by an unknown falling weight W through a height of 40 mm in a vertical bar of length 5 m and of cross-sectional area 500 mm^2 is 1.8 m. Find the unknown weight W , assuming the modulus of Elasticity equals to 200 GPa.
5. a) Write down (without proof) the expression of shearing stress (τ) induced in the surface of a circular shaft of radius (r), when it is subjected to a twist (ϕ) over a length (L) and a twisting moment (T).

b) State the assumptions to be made for deriving the above relationship.

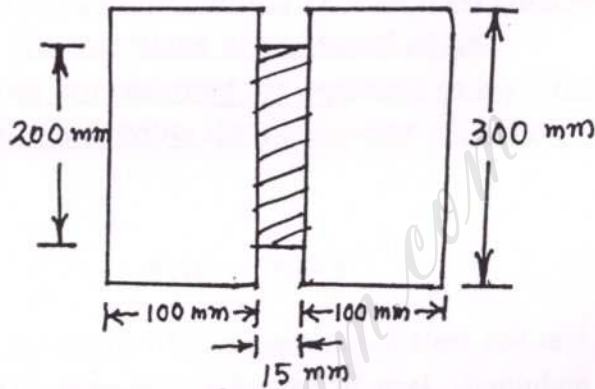
c) In a hollow circular shaft of outer diameter and inner diameters 200 mm and 100 mm respectively, the maximum allowable shearing stress is 40 N/mm^2 . Find the maximum power which the shaft can safely transmit when rotating at a speed of 300 rpm. What should be the angle of twist per unit length of the shaft? Assume $G = 100 \text{ GN/m}^2$.

SECOND HALF

6. A beam ABCD 7 m long is simply supported at A and C on a span of 5 m, CD being an overhang of 2 m. A uniformly distributed load of 4 kN/m acts on the simply supported span AC with a downward concentrated load of 11 kN acting at B at a distance of 2 m from the left hand end A. Another downward point load of 4 kN acts at the free end D. Draw the shear force and bending moment diagrams for the beam mentioning values at significant points. Find also the point of contra flexure, if any.

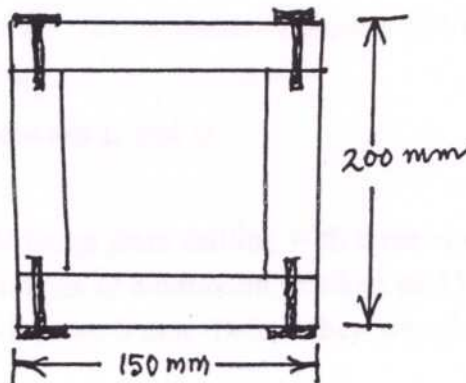
(AM-401)

7. a) Distinguish between bending moment and moment of resistance of a beam.
 b) A flitched timber beam consists of two rectangular joists 100 mm wide and 300 mm deep with a steel plate 200 mm deep and 15 mm thick placed symmetrically between and clamped to them. Calculate the total moment of resistance of the section if the allowable stress in rectangular joists is 9 MN/m^2 .
 Given $E_s = 20 E_w$. (Refer Fig.Q.7)



[Fig.Q.7]

8. A beam of channel section 120 mm overall depth and 60 mm wide has uniform thickness of 15 mm for both flange and web. A vertical shear force of 50 kN is applied at one section. Draw the shear stress distribution diagram across the section mentioning important values. Also find the ratio between the maximum and the mean shear stresses.
9. a) Explain with neat sketches how in a beam subjected to transverse loading, horizontal shear stress is developed along with the vertical component.
 b) A box beam shown in Fig.Q.9 is made up of four 150 mm x 25 mm wooden planks connected by screws. Each screw can safely transmit a shear force of 1250 N. Estimate the necessary minimum spacing of screws along the length of the beam if the maximum shear force transmitted by the cross section is 5000 N. Sketch corresponding shear stress distribution across the section.



[Fig.Q.9]

(AM-401)

10. A cast iron beam has a I-section with unequal flanges. The top flange is 80 mm wide and 20 mm thick, the bottom flange is 160 mm wide and 40 mm thick with the web 200 mm deep and 20 mm thick, the overall depth of the cross-section being 260 mm. The beam is freely supported over a span of 5 metres. If the tensile stress is not to exceed 20 N/mm^2 , find the safe uniformly distributed load which the beam can safely carry. Find also the maximum compressive stress that is developed.

HowToExam.com