BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR

B.E. 3rd Semester (CE) Final Examinations, 2011

Solid Mechanics – I (AM – 301)

Full Marks: 70 **Time: 3 hrs**

*i) Answer **Six** questions, taking **Three** from each **half**.*
ii) Each question carries equal marks.
iii) Two marks are reserved for neatness in each half.
iv) Notations used carry their conventional senses.
v) Assume suitable data, if required.

FIRST HALF

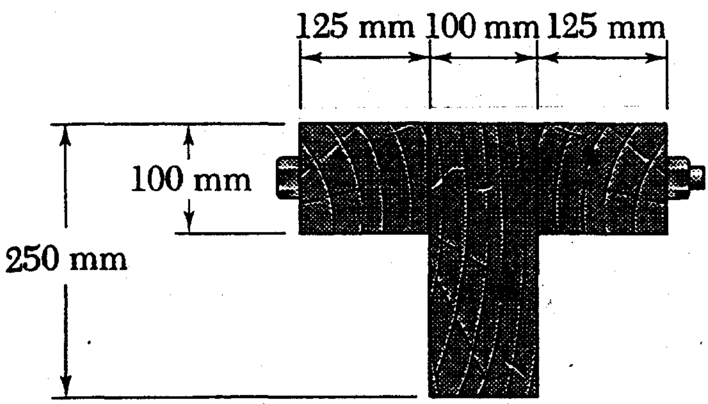

Fig. Q1

1. Three planks are connected as shown **(Fig. Q1)** by bolts of 10 mm diameter spaced every 150 mm along the longitudinal axis of the beam. For a vertical shear force of 11 kN, determine the average shear stress in bolts.

2. (a) Derive the relationship $\frac{T}{J} = \frac{\tau}{\rho} = \frac{G\phi}{l}$ where the symbols carry usual meaning.

(b) One solid shaft and one hollow shaft, having same weight and same length, are made of same material. Under the condition of same maximum shear stress for both the shafts, which shaft will have the more torque carrying capability? Take the diameter of the solid shaft as D and the external and internal diameters of the hollow shaft as D_o and D_i, respectively.

3. A timber beam 150 mm wide and 250 mm deep is to be reinforced by two steel flitches each 10 mm wide and 200 mm deep. Calculate the moment of resistance (safe bending moment) when flitches are attached symmetrically, one either side of the timber. Allowable stress in timber and steel are not to exceed 7 MPa and 120 MPa, respectively. Take $E_s = 2 \times 10^5$ MPa, $E_t = 1 \times 10^4$ MPa.

4. A cast iron beam has an I-section with a top flange 80 mm wide and 20 mm thick, bottom flange 160 mm wide and 40 mm thick, and the web 200 mm deep and 20 mm thick. The beam is simply supported at both the ends with a span of 5 m. If the tensile stress is not allowed to exceed 20 N/mm^2, find the safe uniformly distributed load which the beam can carry over its full span in the downward direction. Also find out the bending stress at the mid height level of the cross-section corresponding to the mid span of the beam and plot the bending stress distribution over that section showing the values.

5. A T-shaped beam with the flange at the top has the following dimensions: flange width 200 mm, flange depth 50 mm, web depth 200 mm and web width 50 mm, the overall depth of the section being 250 mm. The cross-section is subjected to a vertical shear force of 100 kN at some section of the beam. Draw the shear stress distribution over the section mentioning the values at the junction of the web and the flange and also at the neutral axis.

Second half

Q.6. A pile of uniform section is embedded in soil by a depth h (Fig. Q6). The pile supports a structural load P at its top which is transferred to the soil entirely by friction. The variation of friction (f) along the depth of the pile is given by $f = ky^2$, where y is the elevation above the bottom of the pile. Determine the shortening of the pile. Axial rigidity of the pile AE.

Q.7. A bar LMNP fixed at L and P is subjected to axial forces (Fig. Q7). Determine the forces in each part of the bar and the relative displacement of M and N. Take E 200 GN/m^2.

Q.8. Using energy principle, calculate the deflection of joint A (Fig. Q8). Assume that each wire has same cross sectional area A and modulus of elasticity E in tension.

Q.9(a) For a thin walled pressure vessel, explaining the notations and starting from fundamentals, prove that $\frac{\sigma_1}{r_1} + \frac{\sigma_2}{r_2} = \frac{p}{t}$.

(b) A thin-walled cone (wall thickness t) is supported on a horizontal base as shown in Fig. Q9b and subjected to internal gas pressure p. Neglecting the weight of the cone itself, find the principal membrane stresses at the level h above the base.

Q.10(a) A compound beam made up of two bars AC and CD hinged together at C is supported and loaded as shown (Fig. Q10a). Construct shear force and bending moment diagram of the beam. Neglect self-weight of beam.

(b) Construct shear force and bending moment diagram for the railrod tie as shown in Fig. Q10b. Assume the load transmitted to the tie from rails P = 250 kN. The ballast is considered to exert uniformly distributed reactive load o the bottom of the tie. Take a = 1.0 m and l = 3.0 m.

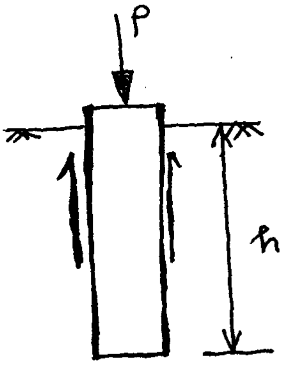

Fig. Q6

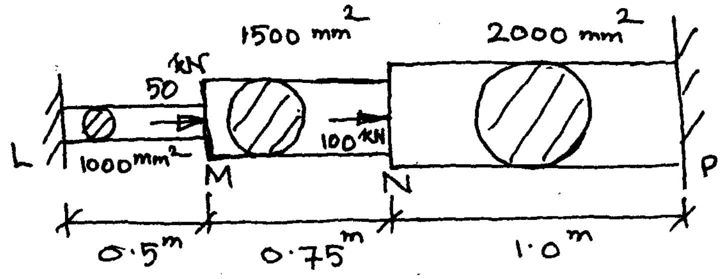

Fig. Q7

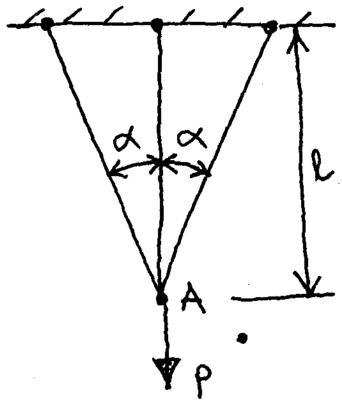

Fig. Q8

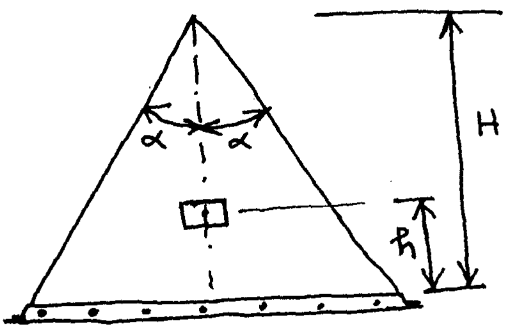

Fig. Q9b

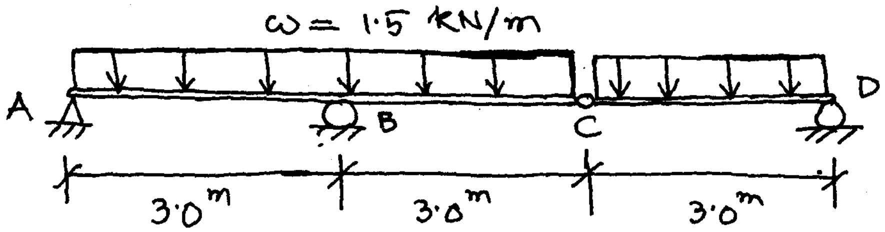

Fig. Q10a

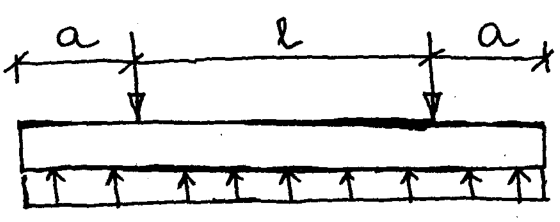

Fig Q10b