BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
B.E. (Aerospace Engineering) Part II 3rd Semester Final Examination, 2011

Subject : **Fundamentals of Structural Mechanics** (Code : **AE 302**)

Time : 3 hrs. Use separate answer script for each half. Full Marks : 70

FIRST HALF

Answer any three questions.
The questions are of equal value.
Two marks are reserved for neatness.

Q.1.(a) Explain the following terms :
(i) Pure Shear (ii) Working Stress (iii) Modulus of resilience
(iv) Principal stress.

(b) Each prong of the cast aluminium fork shown in Fig.Q.1(b) has a 50 mm x 625 mm rectangular cross-section. The allowable tensile stress for cast aluminium is $\sigma_\omega = 70$ N/mm^2 and allowable shear stress for the steel pin is $\tau_\omega = 42$ N/mm^2. For what diameter d of the pin, will the safe load P on the assembly be a maximum ?

Q.2. A copper rod of 25 mm diameter rests inside a steel frame as shown in Fig.Q.2. The two side members of the frame are each 625 mm^2 in cross-section. At a temperature of 20^{0}C, there is a 0.025 mm clearance between the upper end of the copper rod and the top of the frame as shown. Calculate the compressive stress in copper rod, when temperature of the entire system is raised to 60^{0}C. Neglect the bending of the frame. Take E for steel = 200 GPa, E for copper = 100 GPa, α for steel = 1.2 x 10^{-5}/^{0}C and α for copper = 1.8 x 10^{-5}/^{0}C.

Q.3.(a) Establish a relationship between E and G, the elastic modulus and shear modulus of a material respectively.

(b) A bar of 20 mm diameter is tested in tension. It is observed that when a load of 37.7 kN is applied, the extension measured over a gauge length of 200 mm is 0.12 mm and contraction in diameter is 0.0036 mm. Find the Poisson's ratio and elastic constants E & G for the material of the bar.

Q.4. A truncated conical tank having dimensions as shown in the Fig.Q.4, is filled with water. Calculate the membrane stresses σ_1 and σ_2 for an element A on the wall situated as shown, if the thickness of the wall is 0.3 mm.

Q.5. A hollow circular shaft 200 mm external diameter and thickness of metal 25 mm is transmitting power at 200 rpm. The angle of twist over a length of 2 m was found to be 0.5 degrees. Calculate the power transmitted and the maximum shearing stress induced in the shaft. Take G (shear modulus) = 84 kN/mm^2.

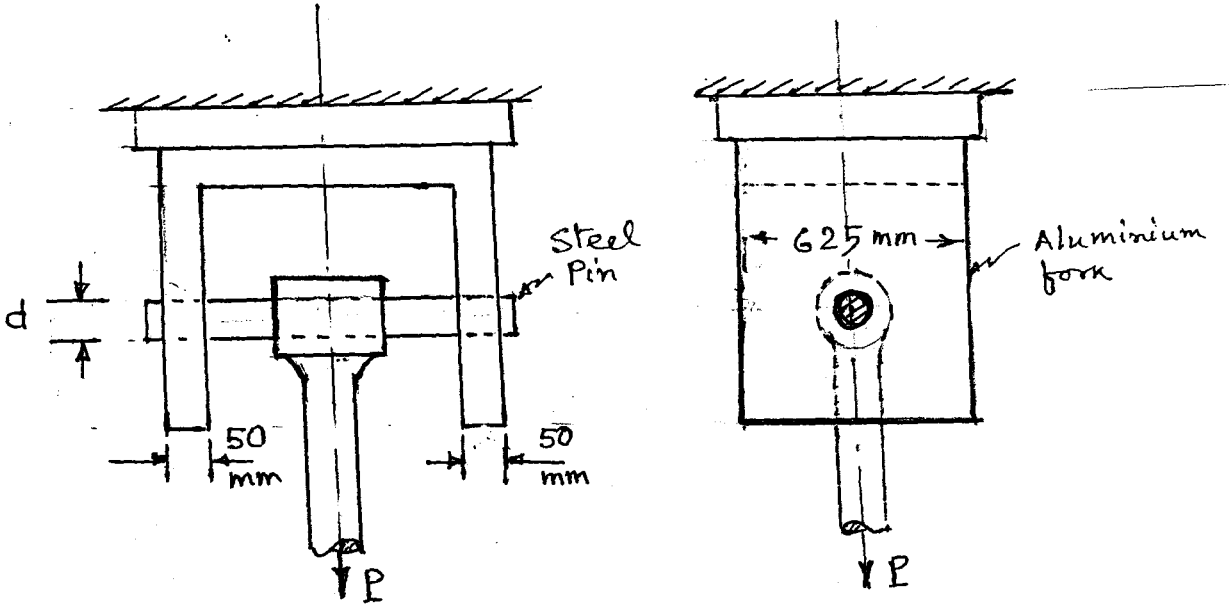

Fig. Q.1 (b)

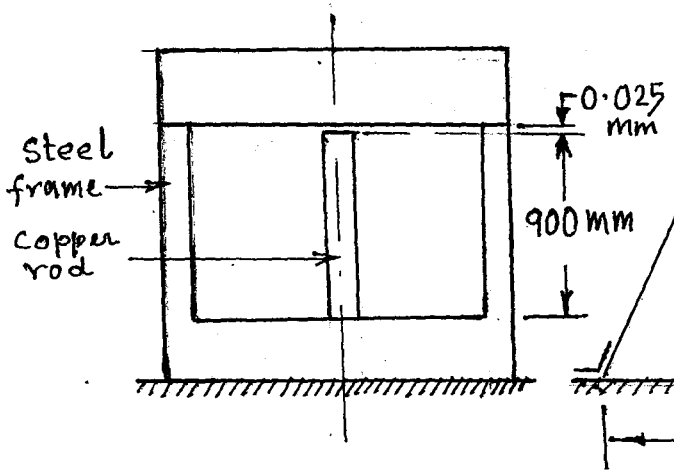

Fig. Q.2

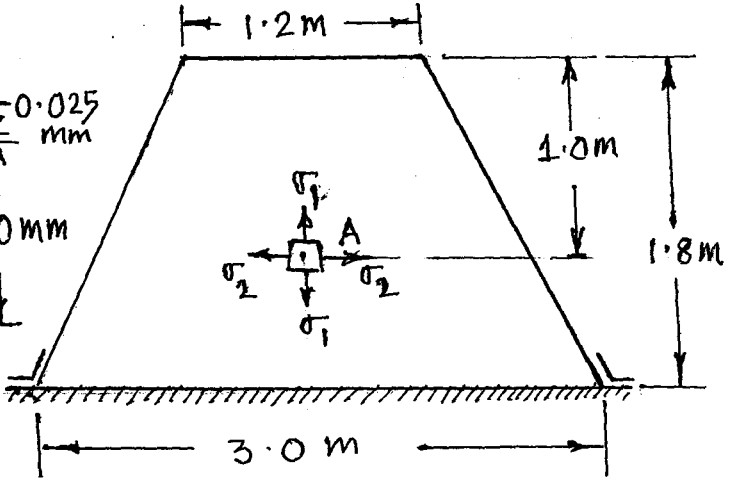

Fig. Q.4

Second Half

(Answer Q. No.6 and any two from the rest)

6. Pick out the best alternative: 1x7 = 7

(a) The simple beam bending theory is otherwise called as (i) Timoshenko beam theory (ii) Euler-Bernoulli beam theory (iii) none of these (iv) all of these

(b) Which one is the correct expression for torsional rigidity (i) EJ (ii) EI (iii) GJ (iv) EG

(c) Which one is the correct expression associated with simple beam bending theory (i) $\frac{dM_x}{dx} = -V_x$ (ii) $\frac{dV_x}{dx} = w$ (iii) $\frac{dV_x}{dx} = -M_x$ (iv) $\frac{dM_x}{dx} = V_x$, where the symbols carry usual meaning

(d) Possibility of appearing shear stress in any loaded structural member is due to (i) bending only (ii) twist only (iii) both bending and twist (iv) neither bending nor twist

(e) Point of contraflexure is the point of (i) reversal of sign of bending moment (ii) reversal of sign of shear force (iii) concentrated bending moment (iv) concentrated shear force

(f) Maximum slope of a loaded wall mounted bracket will occur at (i) tip of the bracket (ii) wall end of the bracket (iii) middle of the bracket

(g) A weightless cantilever beam subjected to a concentrated moment at tip only will produce (i) no SF diagram (ii) no BM diagram (iii) a constant value SF diagram and no BM diagram (iv) a constant value BM diagram and no SF diagram

7. (a) Write down the assumptions for simple bending of beam. 06

(b) Starting from fundamentals, derive the expression for slope and deflection at the tip of a cantilever beam subjected to a uniformly distributed loading. The beam possesses flexural rigidity EI. 08

8. A beam ADBCE of length 10 m is simply supported at its left and right ends A and E respectively. A concentrated load of 80 kN is placed at B, the middle point of the beam and another concentrated load of 30 kN is placed at point C, 8 m away from A. A uniformly distributed load of 20 kN/m is applied, starting from point D, 4 m away from A to the right end of the beam, i.e., point E. Draw the shear force and bending moment diagram of the beam, marking salient points. 14

9. Compare the strengths of the following two sections of the same material, area and thickness. (i) hollow circular section of internal diameter 0.8D and external diameter 1.0D (ii) hollow square section of external dimension a and wall thickness 0.1D. 14

10. Draw the shear stress distribution diagram for a solid circular section having diameter 300 mm, if the active shear force at that section is 75kN. 14