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

Subject : **Mechanics of Solids I** (Code : **AM 304**)

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) Normal stress at a point (ii) Shearing Strain (iii) Modulus of rigidity
(iv) Poisson's ratio.

(b) A homogeneous bar of total length $2l$ is rotating with constant angular velocity ω in a horizontal plane about a fixed axis through its mid point as shown in Fig.Q.1.(b). The cross-sectional area of each half of rotating bar varies linearly from A at the hub to $A/2$ at the tip. Find the maximum stress σ_0 due to centrifugal tension, if the weight per unit volume is γ.

Q.2. A horizontal rigid bar AB weighing 200 kN is hung from ceiling by three vertical rods, each 1 m length and 500 mm^2 in cross-section as shown in Fig.Q.2. If the temperature rise is 40^0C, estimate the load carried by each rod and also determine the vertical displacement of the bar AB.
Take $E_S = 200$ GPa, $E_C = 100$ GPa, $\alpha_S = 1.2 \times 10^{-5}/^0$C and $\alpha_C = 1.8 \times 10^{-5}/^0$C.

Q.3.(a) Derive the expression of normal component and shear component of stress developed on an oblique section of a bar of cross-sectional area A, when subjected to an axial force P. If the normal stress and shear stress on an oblique plane of a bar are 82.5 N/mm^2 and 27.5 N/mm^2 respectively, find values of normal stress σ_X and the angle α defining the aspect angle.

(b) Compare the strain energy stored in the two members as shown in the Fig.Q.3.(b) when both are subjected to the same axial force P. Assuming both having the same modulus of elasticity.

Q.4. A rubber torus inflated to a pressure p = 0.1 N/mm^2 has dimension as shown in Fig.Q.4. Calculate the membrane stresses on the elements at A and at B, if a = 300 mm, b= 400 mm and c = 200 mm. Thickness of the wall = 2.5 mm.

Q.5. A hollow propeller shaft of a steam ship is to transmit power 3750 kW at 240 rpm. If the internal diameter is 0.8 times the external diameter and if the maximum shear stress developed is to be limited to 160 N/mm^2, determine the size of the shaft.

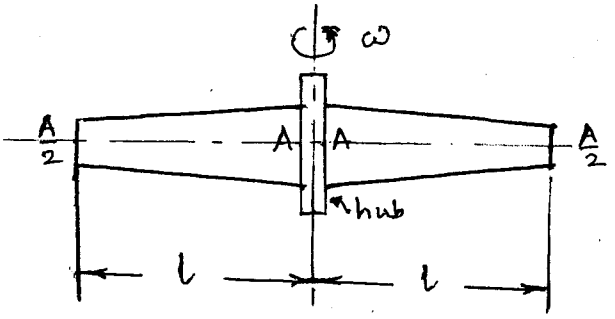

Fig. Q1(b)

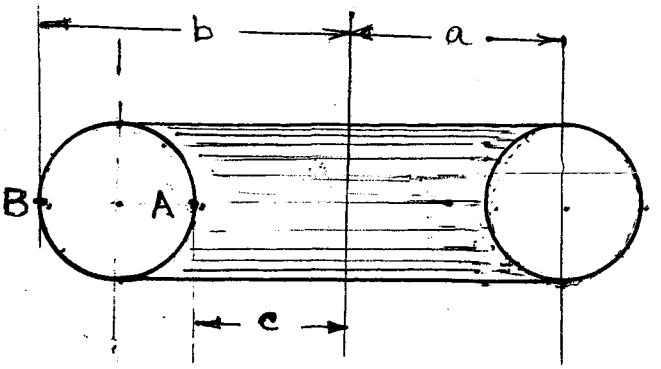

Fig. Q.4

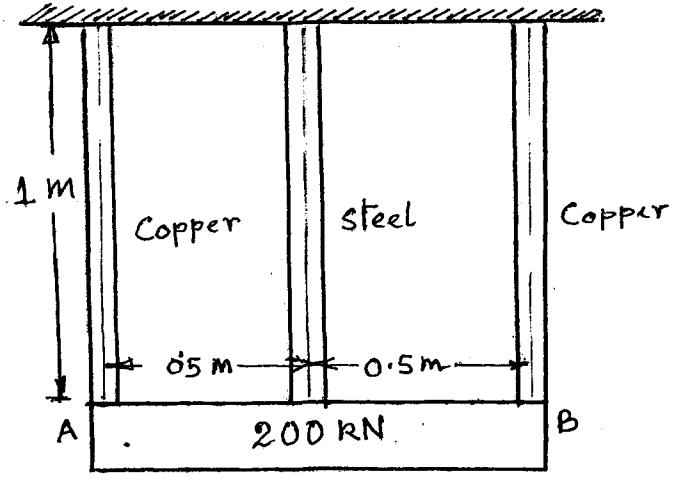

Fig. Q.2

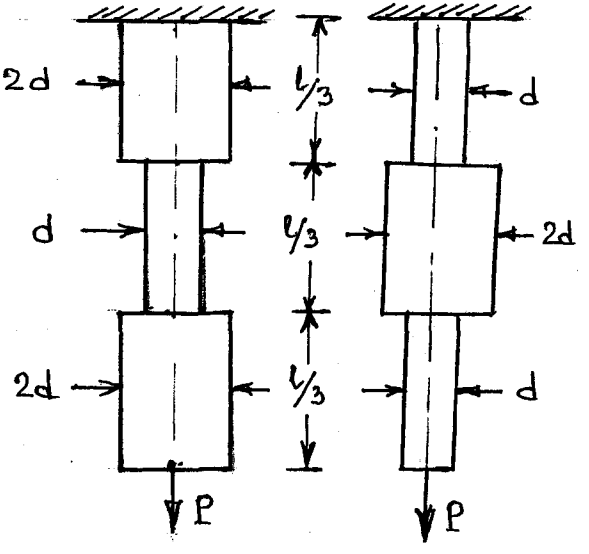

Fig. Q3(b)

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 flexural 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 deflection 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 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) Establish the governing differential equation for the determination of deflection of a 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 ADCBE of length 10 m is simply supported at its left end A and at point B, 8 m away from A. A concentrated load of 80 kN is placed at C, the middle point of the beam. 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 and point of contraflexure. 14

9. Compare the strengths of the following two sections of the same material, area and thickness. (i) hollow circular section of internal diameter 0.9D and external diameter 1.0D (ii) hollow square section of external dimension a and wall thickness 0.05D. 14

10. Draw the shear stress distribution diagram for a trapezoidal section having top width 100 mm, bottom width 200 mm and height 300 mm, if the active shear force at that section is 50kN. 14