BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR

B.E. 3rd Semester (CE) Final Examinations, 2012

Mechanics of Deformable Bodies (AM – 310)

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

1. (a) Derive the relationship $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{\rho}$ where the symbols carry usual meaning.

(b) A water pipe of 1200 mm internal diameter and 12 mm thickness is running full. If the bending stress is not to exceed 56 N/mm^2, find the greatest span on which the pipe may be simply supported. Steel and water weight 76.8 kN/m^3 and 10 kN/m^3 respectively.

2. A 1.6 m long hollow steel shaft (G = 77000 MPa) of 42 mm outer diameter is to transmit 120 kW between a turbine and a generator at 2012 rpm. Knowing that the allowable shearing stress is 65 MPa and the angle of twist must not exceed 3°, determine the safe inner diameter of the shaft. Also plot the shear stress distribution across the cross section of the hollow shaft.

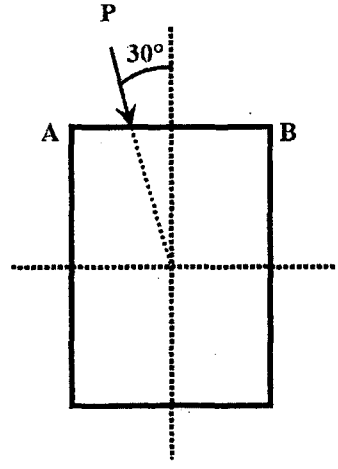

Fig. Q3a

3. a) A simply supported beam of rectangular cross-section 30 mm wide, 50 mm deep and 2.4 m long is subjected to a load of P = 200 N at the mid span of the beam as shown in **Fig. Q3a.** Determine the resultant bending stresses at the corners A and B. Also show the neutral axis.

b) For a curved beam in pure bending with mean radius R = 150 mm, width b = 60 mm and depth h = 36 mm, determine the distance ($\bar{y}$) between the centroid and neutral axis. Also find out the value of the ratio of $\sigma_{min}/\sigma_{max}$.

4. A cantilever beam of 6 m length is loaded by a downward concentrated load of 60 kN at the free end. The beam has an I-section. 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. Draw the shear stress distribution diagram showing the values at the important locations across a section where the shear stress is maximum within the beam.

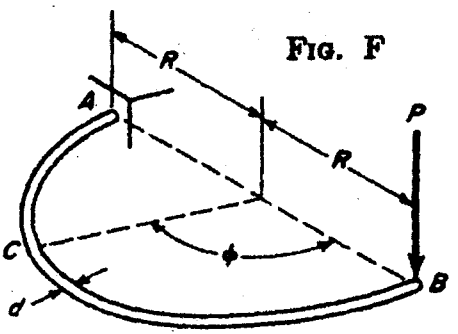

FIG. F

Fig. Q5a

5. a) A shaft of diameter d, bent in the form of a semicircle AB of radius R, is built-in at A and loaded at B by a force P acting perpendicular to the plane of the ring as shown in Fig. **Q5a.** Assuming that d is small compared with R so that the theory of bending of straight bars may be used, find the value of ϕ for which the principal stress σ_1 will be a maximum.

b) Explain the 'distortion energy theory' of failure for the ductile material.

2ND HALF

Answer any three.

Q.6. A copper rod and a steel rod are joined together as shown in Figure Q.6. There is a gap of 0.1mm between the rigid support and the end of the bar at 27^0C. Determine the stresses in the bars when the temperature becomes 50^0C.
Assume $E_S = 200$ GPa, $E_C = 120$ GPa ; $\alpha_S = 12 \times 10^{-6}/^0$C , $\alpha_C = 16 \times 10^{-6}/^0$C .

Q.7. In the system shown in Figure Q.7, find the stresses in the brass and steel bars. The brass bar has an area of 600 mm^2 and the steel bar has an area of 400 mm^2. $E_S = 200$ GPa, $E_b = 90$ GPa.

Q.8. At a point in a vertical cross-section of a beam there is a resultant stress of 50 MPa, which is inclined upward at 35^0 to the positive direction (towards right) of the horizontal axis. On the horizontal plane through this point, there is only shearing stress. Find the magnitude and direction of resultant stress on the plane which is inclined at 40^0 to the vertical and 95^0 to the given resultant stress.

Q.9. A beam 14 m long is supported at 3 m and 12 m from the left end. It carries a load uniformly varying from 60 kN/m at the left end to 200 kN/m at the right end. Draw SF and BM diagram specifying values at important points. Highlight the locations of point of contraflexure, if any.

Q.10. A thin-walled cone (wall thickness t) is supported on a horizontal base as shown in Figure Q.10 and subjected to internal gas pressure p. Neglecting the weight of the cone itself, find the principal membrane stress σ_1 and σ_2 at the level h below the apex.

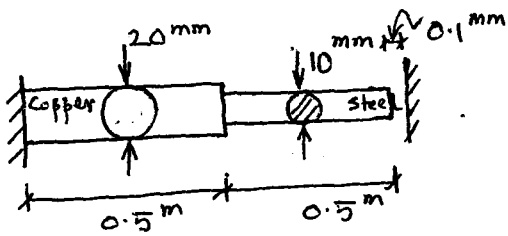

Figure Q6

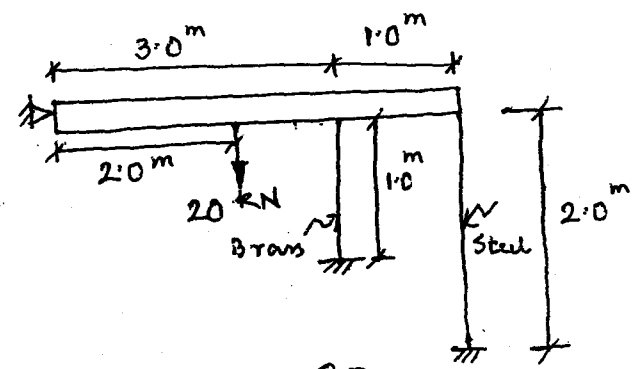

Figure Q7

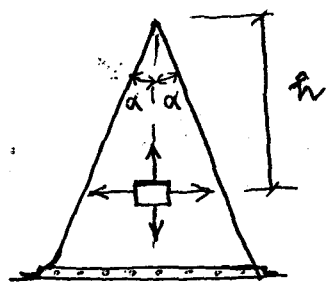

Figure Q10