Code : 021306

B.Tech 3rd Semester Exam., 2013

STRENGTH OF MATERIALS

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Answer any seven sub-questions (select correct answer/fill in the blanks/give short answer) : 7×2=14

(a) The total area under the stress-strain curve of a mild steel specimen test up to failure under tension is a measure of its

(i) breaking strength

(ii) hardness

(iii) stiffness

(iv) toughness

(b) A bar of copper and steel form a composite system. They are cooled to a temperature of 25 °C. What type of stress is induced in the copper bar?

(i) Tensile

(ii) Compressive

(iii) Shear

(iv) Tensile as well as compressive

(c) The planes of maximum normal stresses are inclined at an angle of 45° degree to the plane of pure shear.

(d) A shaft is to be designed on the basis of

(i) maximum allowable shear stress

(ii) maximum allowable angle of twist

(iii) both *(i)* and *(ii)*

(iv) torsional rigidity

(e) In a simply supported beam carrying a uniformly distributed load over its entire span, slope is maximum at

(i) mid span

(ii) supported ends

(iii) $\frac{l}{4}$ from either end

(iv) $\frac{l}{3}$ from either end

(f) The shape of the bending moment diagram for a cantilever beam carrying a uniformly distributed load is

(i) a straight line

(ii) an ellipse

(iii) a hyperbola

(iv) a parabola

(g) In a thin cylinder, the ratio of hoop stress to longitudinal stress is

(i) $\frac{1}{4}$ (ii) $\frac{1}{2}$

(iii) 2 (iv) 4

(h) Maximum normal stress theory is used for

(i) brittle materials

(ii) ductile materials

(iii) both ductile and brittle

(iv) None of the above

(i) Define strain energy of a material.

(j) Define factor of safety of ductile material.

2. (a) Define the principle of superposition. What is its utility? 4

(b) A load of 1000 kN is applied to a reinforced concrete column of 600 mm diameter which has four steel rods of 40 mm diameter embedded in it. Determine the stress in the concrete and the steel. Take E for steel = 200 GPa and E for concrete = 15 GPa. Also find the adhesive force between the concrete and the steel. 10

3. (a) Derive a relation between Young's modulus, modulus of rigidity and the Poisson's ratio. 6

(b) An axial tensile load of 60 kN is applied to a bar of 40 mm diameter and 1·2 m length. The extension of the bar is measured to be 0·275 mm, where the reduction in diameter is 0·004 mm. Calculate Poisson's ratio and the values of the three moduli. 8

4. Draw the shear force and bending moment diagrams for the beam as shown in Fig. 1. Locate the point of contraflexure if any : 14

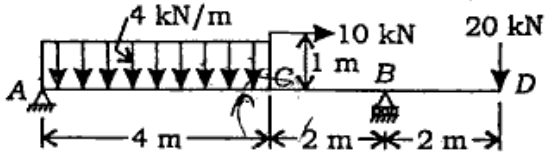

Fig. 1

5. (a) State and prove the moment-area moment. 6

(b) Determine the maximum deflection of a simply supported beam of 5 m length and carries a load which varies uniformly from 15 kN/m at one end to 60 kN/m at the other. $EI = 2$ MN-m^2. 8

6. A freely rotating shaft $ABCDE$ as shown in Fig. 2 is suitably supported at A and D. The shaft is required to transmit power through belt pulley system. 300 kW is input at pulley B while 120 kW and 180 kW are taken

(Continued)

out through pulley C and E respectively. If the shaft frequency is 32 Hz, $G = 75$ GPa, allowable shear stress for the shaft material is 50 MPa and allowable angle of twist is 4°, determine the diameter of the shaft. 14

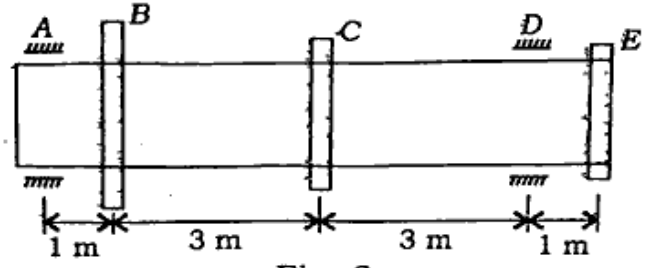

Fig. 2

7. *(a)* What do you mean by plane stress? Discuss the situation with example.

(b) The state of stress at a point is shown in Fig. 3.

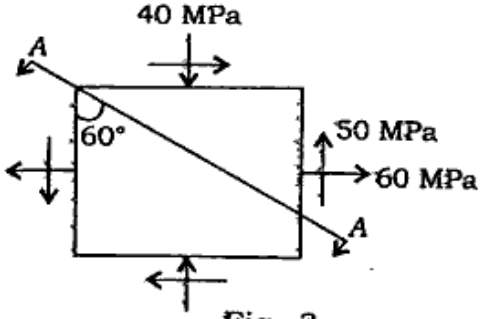

Fig. 3

Determine—

(i) the principal stresses, maximum shear stress and its inclination;

(ii) normal and shearing stress at the two plane *A-A* which makes 60° with the axis.

14

8. *(a)* Show that the volumetric strain of a thin cylindrical shell is the sum of longitudinal strain and twice of hoop strain. 4

(b) The maximum permissible stress in a thick cylinder of 500 mm diameter and of 100 mm thickness is 15 MPa. Find the maximum allowable internal and external pressures on the cylinder, when applied separately. 10

9. *(a)* Develop an expression for strain energy in a shaft subjected to torsion and show that the maximum strain energy in the shaft is twice the total strain energy. 6

(b) Calculate the total elongation of the bar *ABC* by applying Castigliano's theorem, $E = 70 \times 10^3$ MPa, as shown in in Fig. 4. 8

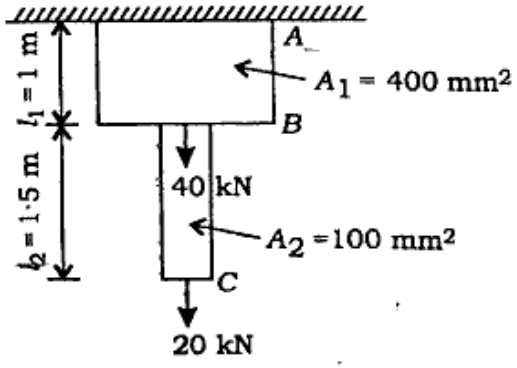

Fig. 4

★ ★ ★