S.E. (Mechanical) (Semester – I) Examination, 2010
STRENGTH OF MACHINE ELEMENT (2003 Course)

Time : 3 Hours Max. Marks : 100

N.B. : *1) Answer* ***3*** *questions from Section –* ***I*** *and* ***3*** *questions from Section –* ***II****.*

2) Answers to the ***two*** *Sections should be written in* ***separate*** *books.*

3) ***Neat*** *diagrams must be drawn* ***wherever*** *necessary.*

4) ***Use*** *of Logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is* ***allowed****.*

5) Assume ***suitable*** *data,* ***if necessary****.*

SECTION – I

UNIT – I

1. a) Derive the expression for thermal stresses in composite bars made of copper and steel. 4

b) Define the following terms : 4

i) Factor of safety.

ii) Lateral strain.

iii) Proportional limit.

iv) Volumetric strain.

c) A cylindrical bar is 20 mm diameter and 1000 mm long. During a tensile test it is found that the longitudinal strain is 4 times the lateral strain. Calculate the modulus of rigidity and the bulk modulus, if its elastic modulus is 1×10^5 N/mm^2. Find the change in volume, when the bar is subjected to a hydrostatic pressure of 100 N/mm^2. 8

OR

2. a) Derive the relation between modulus of elasticity and modulus of rigidity of a material within elastic range. 4

b) A member ABCD is subjected to a point loads P_1, P_2, P_3 and P_4 as shown in fig. 1. Calculate the force P_2 necessary for equilibrium if $P_1 = 45$ kN, $P_3 = 450$ kN, $P_4 = 130$ kN. Determine the total elongation of the member, assuming the modulus of elasticity to be 2.1×10^5 N/mm². 6

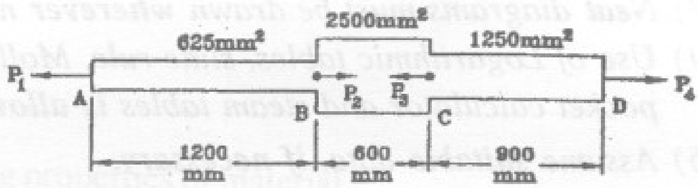

fig. 1 Q. 2 b)

c) The composite bar consisting of steel and aluminium components shown in fig. 2 is connected to two grips at the ends at a temperature of 60°C. Find the stresses in the two rods when the temperature falls to 20°C.

i) If the ends don't yield,

ii) if the ends yield by 0.25 mm.

Take $E_s = 2 \times 10^5$ N/mm², $E_a = 0.70 \times 10^5$ N/mm², $\alpha_S = 1.17 \times 10^{-5}$ per °C and $\alpha_a = 2.34 \times 10^{-5}$ per °C.

Areas of the steel and aluminium bars are 250 mm² and 375 mm² respectively. 6

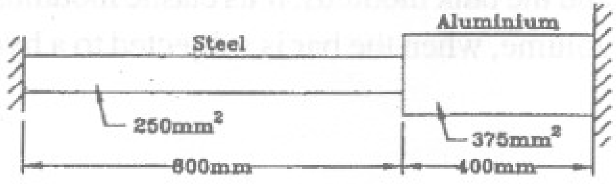

fig. 2 Q. 2 c)

UNIT – 2

3. a) State four assumptions made in theory of pure bending. **2**

b) Derive the expression for shear stress induced at a distance y from neutral axis in the cross-section of a beam subjected to shear force. **6**

c) A simply supported beam carries a uniformly distributed load of 30 N/mm intensity over the entire span of 1 metre. The cross section of the beam is a T-section having the dimension as shown in Fig. 3. Calculate maximum shear stress for the section of beam. **8**

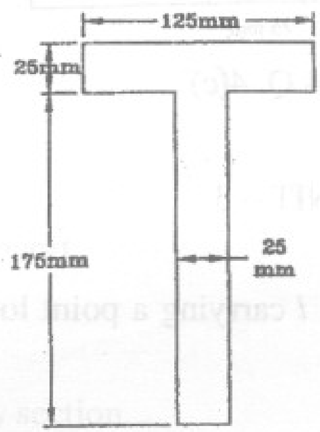

fig. 3 Q. 3 c)

OR

4. a) Explain the following terms in brief

i) Section modulus

ii) Moment of resistance. **4**

b) A cast iron beam section is of I- section with a top flange 80 mm×20 mm thick, bottom flange 160 mm×40 mm thick and the web 200 mm deep and 20 mm thick. The beam is freely supported on a span of 5 metres. If the tensile stress is not to exceed 20 N/mm^2, find the safe uniformly distributed load which the beam can carry. Find also the maximum compressive stress. **6**

c) The beam section shown in Fig. 4 is subjected to a shear force of 35 kN. Sketch the shear stress distribution for the section. 6

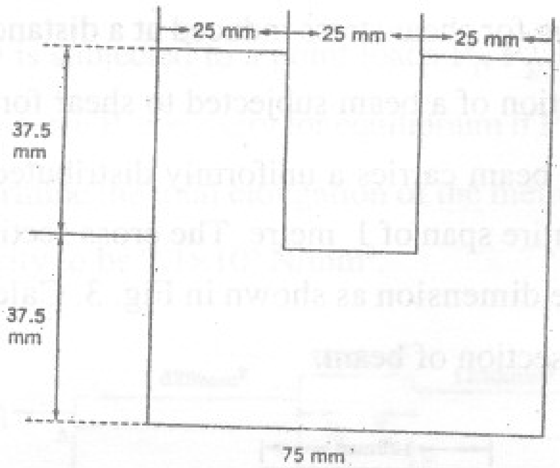

fig. 4 Q. 4(c)

UNIT – 3

5. a) Show that for cantilever of length l carrying a point load at free end i.e. w, deflection at free end is given by :

$$Y = \frac{wl^3}{3EI}$$ 6

b) A beam is 10 m long and is simply supported at the ends. It carries concentrated loads of 100 kN and 60 kN at distances of 2m and 5m respectively from the left end. Calculate the deflection under each load. Find also the maximum deflection.

Take $I = 18 \times 10^8$ mm^4 and $E = 200$ kN/mm^2. Use Macaulay's method. 12

OR

6. a) Derive the equation

$$EI \frac{d^2y}{dx^2} = M$$

with usual notations and further write the relation of shear force and rate of loading. 6

b) Give the relation between real beam and conjugate beam for the following cases : 6

i) Roller support

ii) Free end

iii) Hinged support

iv) Overhanging support

v) Fixed end

vi) Deflection at any section.

c) Determine slope and deflection at free end of given cantilever in terms of EI. (Ref. Fig. 5). Use moment area method. 6

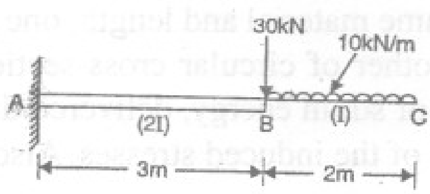

fig. 5 Q. 6 c)

SECTION – II

UNIT – 4

7. a) Explain the concept of principal planes and principal stresses. 4

b) For the state of plane stress below, determine :

i) Principal stresses

ii) Location of principal planes.

iii) Maximum shear stress. 6

Use Mohr's circle method.

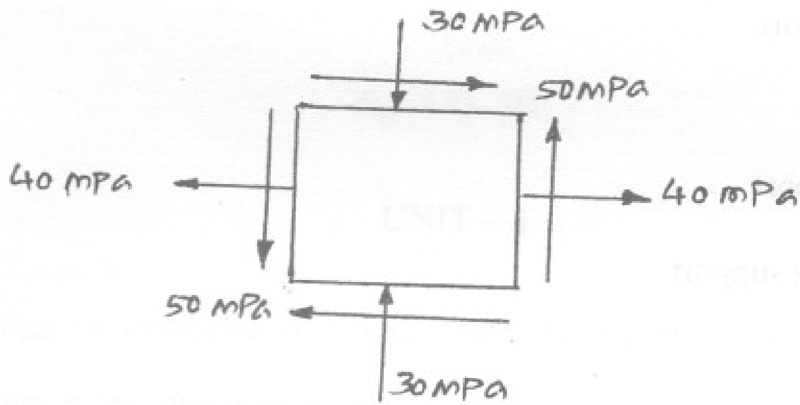

Fig.

c) Derive the expression for change in volume of thin cylindrical shell due to internal pressure. 6

OR

8. a) What are various theories of elastic failure ? Explain Distortion-Energy theory. 4

b) Two elastic bars of the same material and length, one of square cross-section of side 40 mm and the other of circular cross-section of diameter 40 mm absorb the same amount of strain energy, delivered due to gradually applied loads. Calculate the ratio of the induced stresses. Also calculate the ratio of applied loads. 6

c) Determine the diameter of a bolt subjected to an axial pull of 10 kN together with a transverse shear force of 5 kN. Elastic limit in tension is 230 N/m^2m. Factor of safety is 3 and Poisson's ratio is 0.3. Use maximum shear stress theory. 6

UNIT – 5

9. a) Derive Euler's formula for buckling load for column with both ends fixed. Also state the limitations of Euler's formula. 8

b) Determine the diameter of a solid shaft which will transmit 275 kW at 300 rpm. The maximum shear stress should not exceed 30 N/m^2m and twist should not be more than 1° in a shaft length of 2 m. The modulus of rigidity of material is 1×10^5 N/m^2m. 8

OR

10. a) A hollow cylindrical cast iron column is of 150 mm external diameter and 15 mm thickness, 3 m long. It is hinged at one end and fixed at the other. Find :

a) The ratio of Euler's and Rankine's load.

b) For what length, the critical load by Euler's and Rankine's formula will be equal ? 8

b) A solid circular shaft and a hollow circular shaft with internal diameter $\frac{2}{3}$ of external diameter, are of the same material, of equal lengths and are required to transmit the same torque. Compare the weights of the shafts if the maximum shear stress developed in the two shafts are equal. 8

UNIT – 6

11. a) Give the meaning of the following designation of material.

i) Fe 290

ii) SG 370/17

iii) 45 C8

iv) 20 Mn Cr 5

v) 30 Ni 4 Cr 1

vi) 10 C 8 S 10. 6

b) State the advantages and drawbacks of cast iron as an engineering material. 6

c) Explain stress concentration phenomenon and methods to reduce the effect of stress concentration. 6

OR

12. a) Select suitable material for the following components and justify.

i) Turbine blade

ii) Piston.

iii) Connecting rod.

iv) Pulley.

v) Belt.

vi) Gasket. 6

b) Explain :

i) Creep

ii) Endurance limit. 6

c) Define the following properties of material :

i) Malleability.

ii) Resilience.

iii) Toughness.

iv) Rigidity.

v) Brittleness.

vi) Ductility. 6
