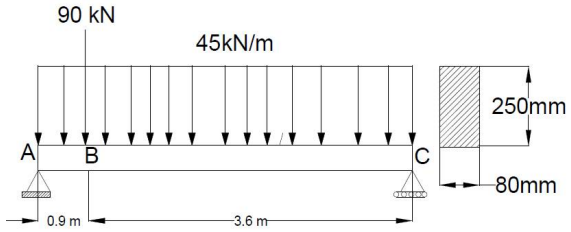

Fig.4

(5 + 5 + 2) = 12

7. (a) Derive the bending formula $M/I = \sigma/y = E/R$.

   (b) Write down the assumptions made in the theory of pure bending.

7 + 5 = 12

Group – E

8. (a) Derive the Torsion formula $T/J = \tau/r = G\varphi/L$.

   (b) The torques shown in Fig.5 are exerted on pulleys A, B and C. Knowing that both shafts are solid, determine the maximum shearing stress in (i) shaft AB (ii) shaft BC.

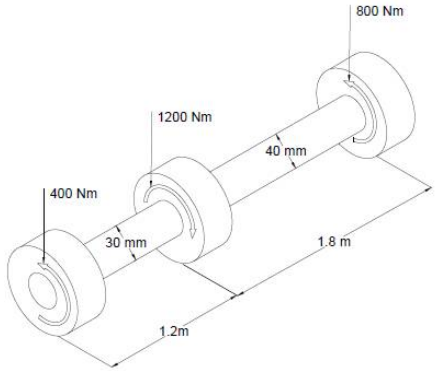

Fig.5

7 + (3 + 2) = 12

9. (a) Derive the expression for Euler critical load of a column whose ends are pinned.

   (b) A hollow cast iron column whose outside diameter is 200 mm has a thickness of 20 mm. It is 4.5 m long and is fixed at both ends. Calculate the safe load by Rankine's formula using a factor of safety of 4. Calculate the slenderness ratio and the ratio of Euler's and Rankine's critical loads. For cast iron take $\sigma_c = 550\ N/mm^2$ and $\alpha = 1/1600$, $E = 8 \times 10^4\ N/mm^2$.

5 + 7 = 12

STRENGTH OF MATERIALS
(MECH 2102)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

   (i) If a part is constrained to move and heated, it will develop
   (a) principal stress (b) tensile stress
   (c) compressive stress (d) shear stress.

   (ii) The energy absorbed in a body, when it is strained within the elastic limits, is known as
   (a) strain energy (b) resilience
   (c) proof resilience (d) modulus of resilience.

   (iii) A beam is loaded as cantilever. If the load at the end is increased, the failure will occur
   (a) in the middle (b) at the tip below the load
   (c) at the support (d) anywhere.

   (iv) A column of length (l) with both ends fixed may be considered as equivalent to a column of length _____ with both ends hinged.
   (a) l/8 (b) l/4 (c) l/2 (d) l

   (v) When a body is subjected to three mutually perpendicular stresses, of equal intensity, the ratio of direct stress to the corresponding volumetric strain is known as
   (a) Young's modulus (b) Modulus of rigidity
   (c) Bulk modulus (d) Poisson's ratio.

   (vi) The deformation of a bar under its own weight compared to the deformation of same body subjected to a direct load equal to weight of the body is
   (a) same (b) double (c) half (d) four times.

(vii) The direct stress induced in a long column is _____ as compared to bending stress.
(a) same (b) more (c) less (d) negligible

(viii) Two shafts 'A' and 'B' have the same material. The shaft 'A' is solid of diameter 100 mm. The shaft 'B' is hollow with outer diameter 100 mm and inner diameter 50 mm. The torque transmitted by shaft 'B' is _____ as that of shaft 'A'.
(a) 1/6 (b) 1/8 (c) ¼ (d) 15/16

(ix) A body is subjected to two normal stresses 20 kN/m² (tensile) and 10 kN/m² (compressive) acting perpendicular to each other. The maximum shear stress is
(a) 5 kN/m² (b) 10 kN/m² (c) 15 kN/m² (d) 20 kN/m².

(x) When there is a sudden increase or decrease in shear force diagram between any two points, it indicates that there is a
(a) point load at the two points (b) no loading between the two points
(c) UDL between the two points (d) UVL between the two points.

Group – B

2. (a) Determine the deformation of the steel rod shown in Fig.1 under the given loads (E = 200 GPa).

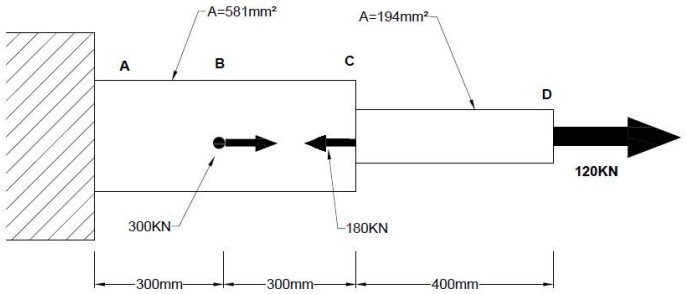

Fig.1

(b) Derive the equations for normal and shear stresses on an oblique plane under biaxial stresses.

7 + 5 = 12

3. (a) Derive the relation among E, ν and G where, E is the Elastic Modulus, ν is Poisson's ratio and G is the Shear Modulus of a given material.

(b) In the arrangement shown in Fig.2, a gap of 0.5 mm exists at the left end of the bronze bar at a temperature of 20°C. Find the temperature at which the normal stress in the aluminium bar will be 75 N/mm². Find also the corresponding exact length of the aluminium bar.

For Bronze, $A_b = 1600\ mm^2$; $E_b = 10.3 \times 10^4\ N/mm^2$; $\alpha_b = 18 \times 10^{-6}$ per °C
For Aluminium, $A_a = 1850\ mm^2$; $E_a = 7.28 \times 10^4\ N/mm^2$; $\alpha_a = 23 \times 10^{-6}$ per °C

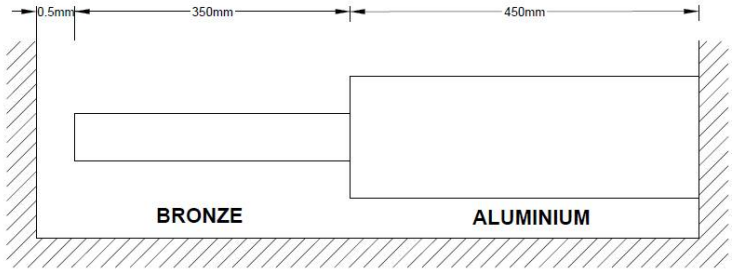

Fig.2

5 + (4 + 3) = 12

Group – C

4. For the state of plane stress shown in Fig.3 determine (i) the principal planes (ii) the principal stresses and (iii) the maximum shearing stress and corresponding normal stress.

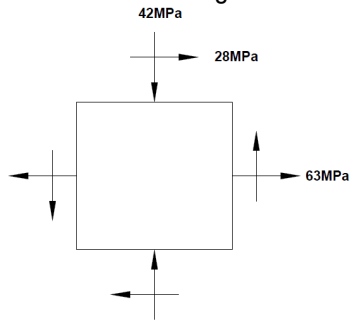

Fig.3

12

5. (a) Find the deflection at the free end of a cantilever of length, l carrying a uniformly distributed load of *w* per unit run over the entire span. Assume uniform flexural rigidity.

(b) A thin cylinder of internal diameter 1.25 m contains a fluid at an internal pressure of 2 N/mm². Determine the maximum thickness of the cylinder if
(i) the longitudinal stress is not to exceed 30 N/mm²
(ii) the circumferential stress is not to exceed 45 N/mm².

8 + (2 + 2) = 12

Group – D

6. Draw the shear force and bending moment diagrams for the simply supported beam shown in Fig.4. Also determine the maximum normal stress due to bending.