2013

STRENGTH OF MATERIALS

Time Allotted : 3 Hours Full Marks : 70

The figures in the margin indicate full marks.

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

GROUP – A

(Multiple Choice Type Question)

1. Choose the correct alternatives for any *ten* of the following: 10 x 1 = 10

i) Which of the following is statically indeterminate structure?

a) A load supported on one member

b) A load supported on two members

c) A load supported on three members

d) Either (a) or (b).

ii) If a composite bar is cooled, then the nature of stress in the part with high coefficient of thermal expansion will be

a) tensile b) zero

c) compressive d) none of these.

iii) The bulk modulus of body is equal to

a) $\frac{mE}{3(m-2)}$ b) $\frac{mE}{2(m+2)}$

c) $\frac{mE}{2(m-2)}$ d) $\frac{mE}{2(m+2)}$

where $\frac{1}{m}=\mu$= Poisson's ratio for the bar material,
E=modulus of elasticity of the material.

iv) When a body is subjected to a direct tensile stress (σ) in one plane, the tangential stress on an oblique section of the body inclined at an angle (θ) to the normal of the section is equal to

a) $\sigma \sin 2\theta$ b) $\cos 2\theta$

c) $\frac{\theta}{2} \sin 2\theta$ d) $\frac{\sigma}{2} \sin 2\theta$

v) The strain energy stored in a body, when the load is gradually applied, is equal to

a) $\frac{(\sigma)}{2E} \times V$ b) $\frac{\sigma}{E} \times V$

c) $\frac{\sigma}{2V} \times E$ d) $\frac{\sigma}{V} \times E$

vi) The BM at the centre of a simply supported beam carrying uniformly distributed load is

a) $w.l$ b) $wl/2$

c) $wl^2/4$ d) $wl^2/8$

vii) The section modulus of a circular section of diameter d is

a) $\pi d^2/32$ b) $\pi d^3/32$

c) $\pi d^3/64$ d) $\pi d^2/64$

viii) A square with side $'a'$ of a beam is subjected to a shearing force of $'F'$. The value of the shear stress at the top edge of the section is

a) zero b) $0.5\ F/a^2$

c) F/a^2 d) $1.5\ F/a^2$

ix) A simply supported beam of span l is subjected to a uniformly distributed load w per unit length over the whole span. The maximum deflections at the centre of the beam is

a) $\frac{5wl^5}{48\ EI}$ b) $\frac{5wl^4}{96\ EI}$

c) $\frac{5wl^4}{192\ EI}$ d) $\frac{5wl^5}{384\ EI}$

x) The strain energy stored in a hollow shaft of eternal diameter D and internal diameter d when subjected to a shearing stress $'\tau'$ is given by

a) $\frac{(D^2+d^2)\tau^2}{GD}$ b) $\frac{(D^2+d^2)\tau^2}{4GD}$

c) $\frac{(D^2-d^2)\tau^2}{GD}$ d) $\frac{(D^2-d^2)\tau^2}{4GD}$

xi) When a closely coiled spring is subjected to an axial load, it is said to be under

a) bending b) shear

c) torsion d) all of these.

xii) The design of a thin cylinder shell is based on

a) internal pressure b) diameter of shell

c) longitudinal stress d) all of these.

GROUP – B

(Short Answer Type Questions)

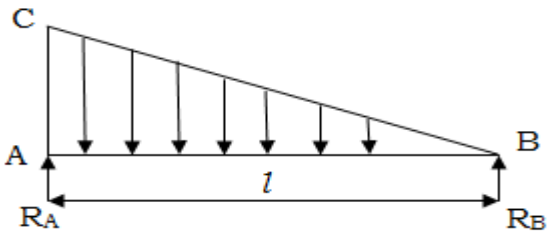
Answer any *three* of the following. 3 x 5 = 15

2. A cantilever of length 2 m fails when a load of 2 kN is applied at the free end. If the section of the beam is 40 mm × 40 mm. find the stress at the failure.

3. a) Draw the stress-strain diagram for a ductile material. 3

b) In the deduction of the relation $T = \theta GJ$. What is the major assumption made? 2

4. A simply supported beam with UVL from zero at one end to w/unit length at another end. Derive the relations of SF and BM and draw the corresponding diagrams.



5. A steel column is of length 8 m and diameter 600 mm with both ends hinged. Determine the crippling load by Euler's formula. Take E=2.1 x 10^5 N/mm^2 .

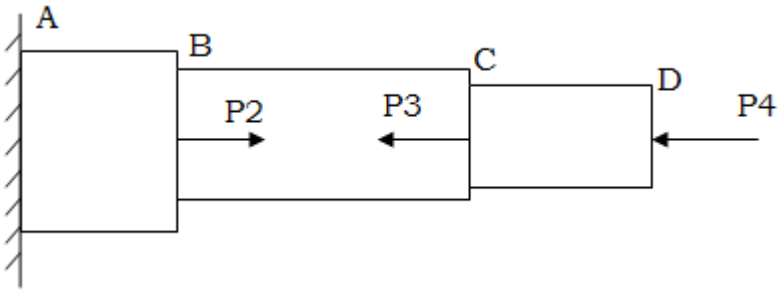
6. a) Explain the classification of column.

   b) Write the assumptions made in the Euler's column theory. 2+3

7. The following details refer to the bar as shown:

Portion	Length	Cross-section
AB	600 mm	40 mm × 40 mm
BC	800 mm	30 mm × 30 mm
CD	1000 mm	20 mm × 20 mm

If the load $P_4 = 80\ kN$, $P_2 = 60\ kN$ and $P_3 = 40\ kN$, find the extension of the bar, where $E = 2 \times 10^5\ N/mm^2$.



GROUP – C

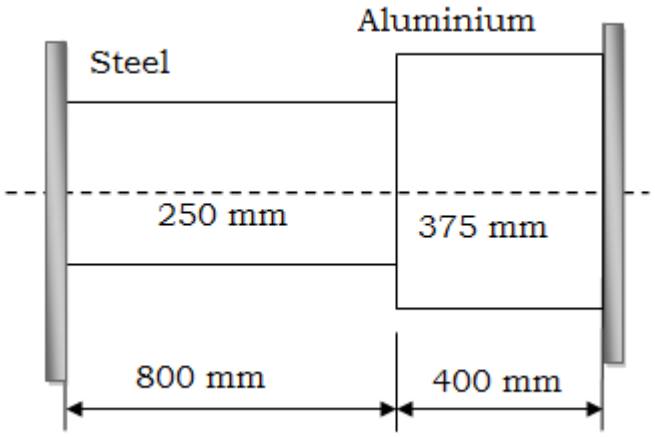
(Long Answer Type Questions)

Answer any *three* of the following. 3 x 15 = 45

8. a) With assumptions, derive the bending equation $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$, where the symbols have their usual meanings. 8

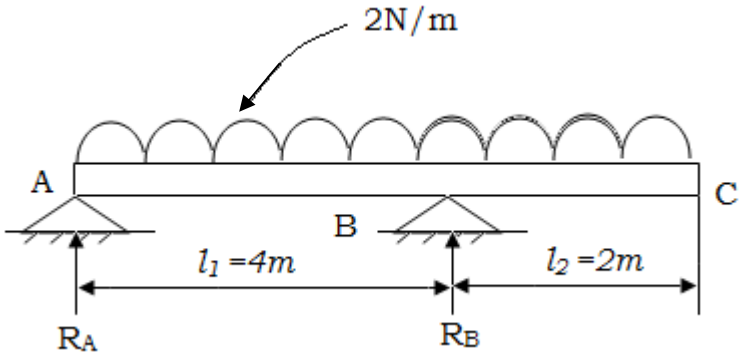
   b) A square beam 20 mm × 20 mm in section and 2 m long is supported at the ends. The beam fails when a point load of 400 N is applied at the centre of the beam. What uniformly distributed load per m length will break a cantilever of same material 40 mm wide, 60 mm deep and 3 m long? 7

9. a) A composite bar consisting of steel and aluminium components shown in figure, 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 and if the ends do not yield, cross-sectional areas of the steel and aluminium bars are 250 mm^2 and 375 mm^2 respectively. Take $E_s = 2 \times 10^5\ N/mm^2$, $E_a = 0.70 \times 10^5\ N/mm^2$, $\alpha_s = 1.17 \times 10^{-5}$ /°C and $\alpha_a = 2 \times 10^5$ /°C. 8



b) Draw the Mohr's circle diagrams and show normal, tangential and resultant stresses when a member is subjected to two mutually perpendicular principal stresses, unequal and alike. 7

10. Draw the S.F. and B.M. diagrams for the overhanging beam carrying uniformly distributed load of 2 kN/m over the entire length as shown in following figure. Also locate the point of contraflexure.



11. a) Derive an expression for the critical load in a long column when one end fixed and other end free.

b) A mild steel tube 4 m long, 3 cm internal diameter and 4 mm thick is used as a strut with both ends hinged. Find the collapsing load. What will be the crippling load if

i) both ends are built-in?

ii) one end is built-in one end is free. 5+10

========