STRENGTH OF MATERIALS
(CIVL 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) A circular bar is subjected to a torque "*T*". The polar moment of inertia of the bar is "*J*" and modulus of rigidity of the material is "*G*". If the angle of twist is "θ", then the torsional rigidity of the bar is,
(a) T/J (b) T/ θ (c) T/G (d) None of these.

(ii) Wherever the bending moment is maximum the shear force is
(a) Zero (b) Also maximum
(c) Minimum (d) Does not depend on shear force.

(iii) A two dimensional element is subjected to pure shear of magnitude 40 MPa. What is the value of the major principal stress?
(a) 40 MPa (b) 60 MPa (c) 80 MPa (d) 100 MPa.

(iv) Maximum bending moment in a simply supported beam carrying a un udl is
(a) $\frac{wl^2}{8}$ (b) $\frac{wl^2}{4}$ (c) $\frac{wl^3}{4}$ (d) $\frac{wl^2}{2}$

(v) What is the inclination of a plane on which the shear stress is maximum with respect to the principal plane?
(a) 45^0 (b) 90^0 (c) 0^0 (d) 180^0

(vi) An inverted T-section is subjected to a shear force F. The maximum shear stress will occur at
(a) Top of the section (b) neutral axis of the section
(c) junction of web and flange (d) bottom of the section

(vii) Shear force(V) and bending moment(M) are related as
(a) V = M/Z (b) V = dM/dx (c) V = $\int Mdx$ (d) V = $\int MZdx$

(viii) The flexural rigidity of a beam is
(a) E/I (b) EI (c) I/E (d) E^2I

(ix) A simply supported beam of length L carrying a concentrated load at the mid span. Maximum bending moment value will be
(a) WL/2 (b) WL/4 (c) WL/8 (d) WL/16.

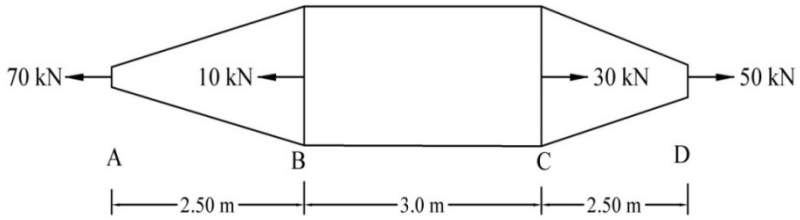
(x) Section modulus of a rectangular section having width *b* and depth *d* is given by
(a) $bd^2/6$ (b) $bd^3/8$ (c) $bd/6$ (d) $b^2d/6$

Group – B

2. (a) Draw the stress – strain relationship on a graph paper using the table given below. Identify whether the material is ductile or brittle. Identify proportional limit, yield stress, plastic zone, ultimate stress and breaking stress from the stress – strain curve.

Strain	Stress (N/mm^2)
0	0
0.001	10
0.002	20
0.003	30
0.004	40
0.005	38
0.006	37
0.007	64
0.008	70
0.009	65
0.01	52

(b) A circular bar of varying cross section is subjected to the axial forces as given in the following figure. The diameter of the bar at location 'A' is 15 mm, at 'B' is 40 mm and at 'D' is 25 mm. The bar has uniform cross-section at 'BC'. Find out the total elongation of this bar. Consider modulus of elasticity (E) = 2×10^8 kN/m^2.



8 + 4 = 12

3. (a) An element is subjected to pure shear where the shear stress is 80 N/mm^2. Draw a Mohr Circle and identify the principal plane. What are the major and minor principal stresses? Find out the principal stresses if the element rotates by 25^0 anticlockwise?

(b) For a thin walled pressurized vessel, prove the following relationship,

$$\frac{\sigma_1}{r_1} + \frac{\sigma_2}{r_2} = \frac{p}{t}$$

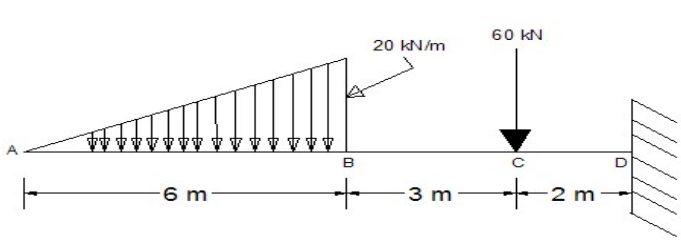
where
σ_1 = Longitudinal stress

σ_2 = Hoop stress
r_1 and r_2 = Radii of curvatures of the vessel.
p = Internal pressure acting in vessel.
t = Wall thickness of the vessel.

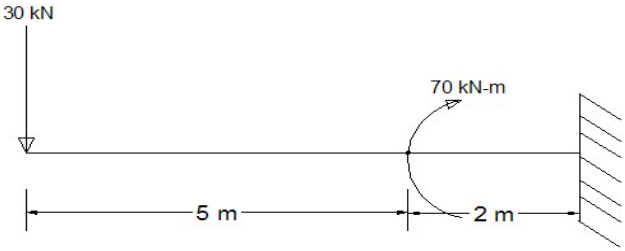
6 + 6 = 12

Group – C

4. Draw the SFD and BMD of the following beams.



(a)



(b)

6 + 6 = 12

5. (a) What do you understand by Section Modulus? Find out section modulus for rectangular section and circular section.

   (b) An "I" section beam 350mm × 250 mm has a web thickness of 12.5 mm and a flange thickness of 25 mm. It carries a shearing force of 200 kN at a section. Sketch the shear stress distribution across the section.

6 + 6 = 12

Group – D

6. (a) An element is subjected to pure shear condition where the shear stress has magnitude 50 N/mm^2. Draw a Mohr Circle for the element and identify the principal plane and major and minor principal stresses. What will be the magnitude of the major principal stress if the element is rotated by 10° clockwise?

   (b) A thin walled balloon having diameters 25 mm and 35 mm along the horizontal and vertical directions, respectively and wall thickness 5 mm is subjected to internal pressure 50 kg/mm^2. Find out the meridonial and hoop stresses if the hoop stress is twice the meridonial stress.

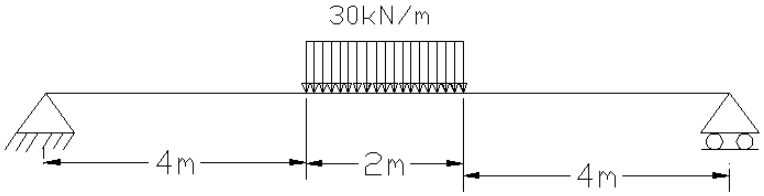
6 + 6 = 12

7. A solid circular shaft of length 2.0 m and diameter 50 mm is fixed at one end and free at the other end. The first 1.0 m length of the shaft is made of aluminium and the second 1.0 m length is made of brass. Maximum allowable shear stresses are 75 MPa and 50 MPa for aluminium and brass, respectively. The modulus of rigidity are 0.27 × 10^5 MPa and 0.34 × 10^5 MPa for aluminium and brass, respectively. Find out the maximum allowable torque acting at the free end of that shaft if its angle of twist is restricted upto 1^0.

12

Group – E

8. (a) A simply supported beam of span 10m carries an udl of 30 kN/m as shown. Find slope at the two ends and deflection at the midpoint. Use double integration method. Given E = 200 kN/mm^2 and I = 1.25 × 10^9 mm^4. Assume suitable data if not provided.



(b) Derive the expression for strain energy stored in a bar due to axial force.

8 + 4 = 12

9. (a) Consider a slender simply supported aluminum column 2.0 m long and circular in cross section. It has a hollow cross-section where the outside diameter is 50 mm. Calculate the necessary internal diameter to prevent failure by buckling if the critical axial load applied on the top of the column is 30 kN. Take *E* for aluminum as 70 GN/m^2.

(b) Find out the 'core' of an eccentrically loaded short column of shorter dimension '*b*' and longer dimension '*d*'.

9 + 3 = 12

Department & Section	Submission Link
CE BACKLOG	https://classroom.google.com/c/MjQ4ODI4ODY4MjY5/a/Mjc0NTQ3MzIzOTA5/details