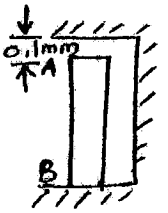
B.Tech. Degree III Semester Examination in Marine Engineering December 2012

MRE 304 MECHANICS OF SOLIDS

Time : 3 Hours Maximum Marks : 100

I. (a) Derive the relationship involving modulus of elasticity, modulus of rigidity and Poisson's ratio. (8)

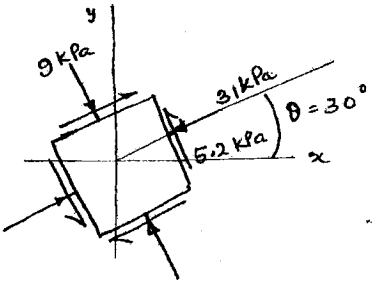
(b) A copper bar AB of length 1m is placed in position at room temperature with a gap of 0.1mm between end A and a rigid wall. Calculate the stress in the bar if the temperature rises by 40°C. For copper $\alpha = 17 \times 10^{-6} /^{o} C$ and $E = 110\ GPa$. (12)



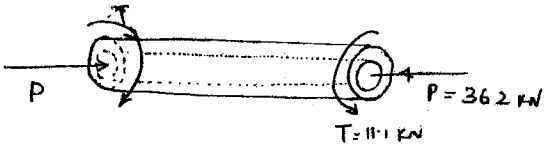
OR

II. (a) Derive the relationship for strain energy stored in a material when it is subjected to an axial stress. (8)

(b) An element in plane stress is rotated through a known angle $\theta = 30^{o}$. On the rotated element, the normal and shear stresses have magnitudes and directions as shown in figure. Determine the stresses σ_x, σ_y and τ_{xy}. Also determine the principal stresses, orientation of principal planes and maximum shear stress. (12)

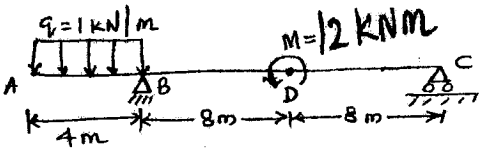


III. A generator shaft of hollow circular cross section having outside diameter 200mm and inside diameter 160mm is subjected simultaneously to a torque T = 11.1 KNm and an axial compressive load of P=362 KN. Determine the maximum tensile stress σ_t, maximum compressive stress σ_c and maximum shear stress in the shaft. (20)

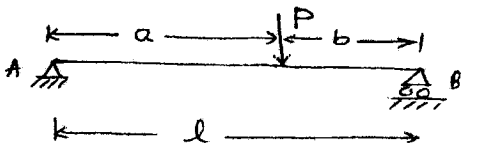


OR

IV. Construct shear force and bending moment diagrams for the beam with an overhang as shown. (20)

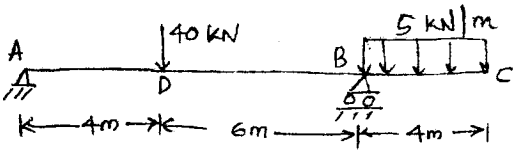


V. Determine the expressions for the deflection below the load, the maximum deflection and slopes at the supports of the beam loaded and supported as shown. (20)



OR

VI. Using moment area method, determine the deflection at the free end, maximum deflection in the span AB and angles of rotation θ_a, θ_b and θ_c for the beam shown. Take $E = 200Gpa,$, $I = 1.28 \times 10^9\ mm^4$. (20)



VII. (a) Derive the relationship $\frac{T}{J} = \frac{G\theta}{\ell} = \frac{\tau}{r}$ for a solid circular shaft subjected to torsion. (10)

(b) A hollow circular shaft and a solid circular shaft of the same material are to be designed to transmit the same torque with the maximum shear stress. If the inner radius of the hollow shaft is 0.8 times the outer radius find: (10)

(i) the ratio of the outer diameter of the hollow shaft to the diameter of the solid shaft.

(ii) the ratio of the weight of the hollow shaft to the weight of the solid shaft.

OR

VIII. (a) Derive the relationship for the deflection of a close coiled helical spring subjected to an axial force. (10)

(b) A closely coiled helical spring of round steel wire 10mm in diameter having 10 complete turns with a mean diameter of 12cm is subjected to an axial load of 200N. Determine (10)

(i) the deflection of the spring

(ii) maximum shear stress in the wire

(iii) stiffness of the spring.

Take G = 8 x 10^4 N/mm^2.

IX. (a) Explain any one theory of failure of a ductile material. (8)

(b) A 2m long pin ended column of a square cross section is to be made of wood. Assuming $E = 12.5\ GPa$, $\sigma_{allow} = 12MPa$ for compression and using a factor of safety of 2.5 in computing Euler's critical load for buckling, determine the size of the cross section if the column is to safely support 100kN load. (12)

OR

X. (a) Derive the expression for the Euler's crippling load for pinned ended column subjected to an axial compressive force. (10)

(b) A steel spherical pressure vessel is being designed for a pressure of *6MPa* and an inside diameter of 600mm. The yield stress of the steel is *400 MPa*. What is the minimum required thickness '*t*' for a factor of safety against yielding of 2.5? (10)

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