B.Tech Degree III Semester Examination in Marine Engineering, March 2008

MRE 304 MECHANICS OF SOLIDS

Time : 3 Hours | Maximum Marks : 100

I. (a) Explain the terms

(i) Poisson's ratio (ii) Elastic limit
(iii) Bulk modulus (iv) Strain energy
(v) Hook's Law (2 x 5 = 10)

(b) A steel tube of 30cm external diameter and 25 mm internal diameter encloses a gun metal rod of 20 mm diameter to which it is rigidly joined at each end. The temperature of the whole assembly is raised to 140^0C and the nuts on the rod are then screwed lightly home on the ends of the tube. Find the intensity of stress in the rod when the common temperature has fallen to 30^0C. The value of E for steel and gun metal is 2.1×10^5 N/mm^2 and 1×10^5 N/mm^2 respectively. The linear co-efficient of expansion for steel and gun metal is 12×10^{-6} per ^{0}C and 20×10^{-6} per ^{0}C. (10)

OR

II. (a) Derive an expression for the stresses on an oblique plane of a rectangular body, when the body is subjected to a simple shear stress. (8)

(b) The principal stresses at a point across two perpendicular planes are 80 N/mm^2 and 40 N/mm^2. Find the normal, tangential and the resultant stress and its obliquity on a plane at 20^0 with the major principal plane, both analytically and graphically. Also find the intensity of the stress which acting alone can produce the same maximum strain. Take Poisson's ratio equal to 0.25. (12)

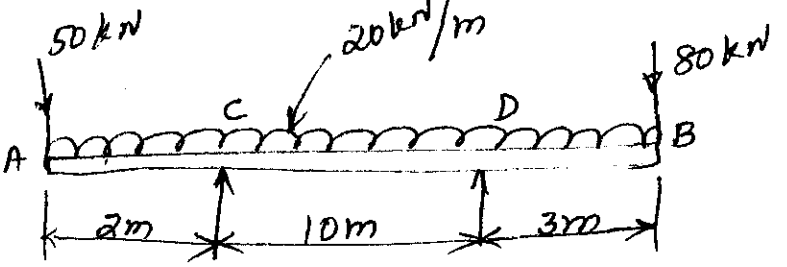
III. (a) What do you mean by the following terms?

(i) Middle third rule for rectangular section
(ii) Middle Quarter rule for circular sections. (6)

(b) A cast iron beam section is of I section with a top flange 80 mm x 20 mm thick, bottom flange 160 mm x 40 mm, thick and the web 200 mm deep and 20 mm thick. The beam is freely supported on a span of 5 meters. 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. (14)

OR

IV. For a beam loaded as shown in figure. Determine the reaction and sketch the shearing force and bending moment diagram giving the maximum value and state where they occur. Also locate the point of contraflexture. (20)



V. (a) What is moment-area method? Where is it used? (5)

(b) A steel girder of uniform section, 14 meters long is simply supported as its ends. It carries concentrated loads of 90 kN and 60 kN at two points 3 metres and 4.5 metres

from the two ends respectively. Calculate.

(i) The deflection of the girder at the points under the two loads

(ii) The maximum deflection

Take I = 64 x 10^{-4} m^4 and E = 210 x 10^{-6}kN/m^2. (15)

OR

VI. A fixed beam AB of length 6m carries point loads of 160kN and 120kN at a distance of 2m and 4m from the left end A. Find the fixed end moments and the reactions at the supports. Draw BM and SF diagrams. (20)

VII. (a) Derive an expression for the shear stress produced in a circular shaft which is subject to torsion. What are the assumptions made in the derivation? (7)

(b) A shaft is to be fitted with a flanged coupling having 8 bolts on a circle of diameter 150 mm. The shaft may be subjected to either a direct tensile load of 400 kN or a twisting moment of 18 kNm. If the maximum direct and shearing stresses permissible in the bolt material are 125 N/mm^2 and 55 N/mm^2 respectively, find the minimum diameter of the bolt required. Assume that each bolt takes an equal share of the load or torque. (13)

OR

VIII. (a) Prove that the maximum shear stress induced in the wire of a close-coiled helical spring is given by $\tau = \frac{16WR}{\pi d^3}$

where τ - maximum shear stress induced in the wire

W - axial load on spring

R - mean radius of spring coil

d - diameter of spring wire. (8)

(b) A close coiled helical spring is to have a stiffness of 1 N/mm of compression under a maximum load of 45N and a maximum shearing stress of 126 N/mm^2. The solid length of the spring (when coils are touching) is to be 45 mm. Find the diameter of the wire, the mean diameter of the coils and the number of coils required. Modulus of Rigidity $C = 4.2\times10^4 \frac{N}{mm^2}$. (12)

IX. (a) Show that in thin cylinder shells subjected to internal fluid pressure, the circumferential stress is twice the longitudinal stress. (8)

(b) Two thick steel cylinders A and B, closed at the ends, have the same dimensions, the outside diameter being 1.6 times the inside. A is+ subjected to internal pressure only and B to external pressure only. Find the ratio of these pressures.

(i) When the greatest circumferential stress has the same numerical value

(ii) When the greatest circumferential strain has the same numerical value. Poisson's ratio = 0.304. (12)

OR

X. (a) Explain any four theories of failure. (10)

(b) Determine the crippling load for a T-Section of dimensions 10 cm x 10 cm x 2cm and of length 5 m when it is used as column with both ends hinged. Take $E = 2.0\times10^5 N/mm^2$. (10)