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***B.Tech. Degree III Semester Supplementary Examination in  
Marine Engineering December 2016***

**MRE 304 MECHANICS OF SOLIDS**

*(Prior to 2013 scheme)*

Time : 3 Hours

Maximum Marks : 100

(5×20=100)

- I. (a) A 15 mm diameter steel rod passes centrally through a copper tube of 50 mm external diameter and thickness 5 mm. The tube is closed at each end by rigid plates of negligible thickness. The nuts are tightened slightly on the projecting parts of the rod. If the temperature of the assembly is raised by 60 °C, calculate the stresses developed in the copper and the steel. Young's modulus for steel and copper are 210 GPa and 105 GPa respectively and coefficient of thermal expansion for steel and copper are  $12 \times 10^{-6}$  per °C and  $17.5 \times 10^{-6}$  per °C respectively. (12)
- (b) A rod tapers uniformly from 40 mm diameter to 20 mm diameter in a length of 400 mm. If the rod is subjected to an axial load of 10 kN, find the extension of the rod. Take  $E=210$  GPa. (8)

**OR**

- II. (a) Explain the construction of 2D Mohr's circle. (8)
- (b) Two planes AB and BC which are at right angles carry shear stresses of intensity 17.5 MPa while these planes also carry a tensile stress of 70 MPa and a compressive stress of 35 MPa respectively. Determine the principal planes and principal stresses. Also determine the maximum shear stress and the planes on which it acts. (12)
- III. (a) Derive the pure bending equation and state its assumptions. (10)
- (b) A steel beam of hollow section of outside 100 mm and inner side 80 mm is used on a span length of 4 m. Find the uniformly distributed load the beam can carry if the bending stress is not to exceed 120 MPa. (10)

**OR**

- IV. (a) Derive the relationship between intensity of loading, shear force and bending moment of a beam. (8)
- (b) A horizontal beam 10 m long carries a uniform distributed load of 180 N/m. The beam is supported at two points 7 m apart so that each support carries half the total load. Draw the shear force and bending moment diagram for the beam. (12)
- V. (a) Explain moment area method to find the deflection of a beam. (8)
- (b) A beam of span 6 m and of uniform flexural rigidity  $EI=40$  MNm<sup>2</sup> is subjected to a clockwise couple of 300 kNm at a distance of 4 m from the left end. Find the deflection at the point of application of couple. Find also the maximum deflection. (12)

**OR**

- VI. (a) Explain advantages and disadvantages of fixed beam compared to statically determinate beams. (8)
- (b) A fixed beam AB of span 6 m is subjected to a concentrated couple of 300 kNm applied at a section C, 4 m from the end A. Find the end moments and draw shear force and bending moment diagram. (12)

**(P.T.O.)**

- VII. (a) A hollow marine propeller shaft turning at 110 rpm is required to propel a vessel at 12 m/s for the expenditure of 6.3 MW of shaft power, the efficiency of the propeller being 68%. The diameter ratio of the shaft is to be  $\frac{2}{3}$  and the direct stress due to thrust is not to exceed 8 MPa. Calculate (i) the shaft diameters and (ii) the maximum shearing stress due to torque. (10)
- (b) A hollow shaft having an inside diameter 60% of its outside diameter is to replace a solid shaft transmitting the same power at the same speed. Calculate the percentage saving in material, if the material to be used is also the same. (10)

**OR**

- VIII. (a) Derive the expression for resultant stiffness of 3 springs arranged in (i) parallel connection and in (ii) series connection. (12)
- (b) A closed coil helical spring is fixed at both ends. A load 'P' is applied to it at an intermediate point on it. If the number of coils above the point of application of the load is 8 and below this point is 6, calculate how the load 'P' will be shared between the upper and the lower parts, if  $P = 1000 \text{ N}$ . (8)
- IX. (a) A thin cylindrical tube with closed ends has an internal diameter of 50 mm and a wall thickness of 2.5 mm. The tube is axially loaded in tension with a load of 10 kN and is subjected to an axial torque of 500 Nm under an internal pressure of 6 MPa. Determine the principal stresses on the outer surface of the tube and the maximum shear stress. (12)
- (b) Derive the hoop stress acting on thin cylinder of radius 'r' and thickness 't' subjected to internal pressure P. (8)

**OR**

- X. (a) Explain any two theories of failure with the help of neat sketches. (10)
- (b) Derive Euler's bulking load for a column with both ends fixed. (10)