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15ME/MA34

Third Semester B.E. Degree Examination, Jan./Feb. 2021

Mechanics of Materials

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Obtain an Expression for Elongation of a bar. **(04 Marks)**

b. A bar made up of two square sections, one of steel and the other of aluminium is shown in Fig Q1(b). The bar is acted upon by a compressive force P. Determine the value of P if the total decrease in length of the bar is 0.3mm. Take $E_s = 205$GPa and $E_{a\ell} = 75$GPa.

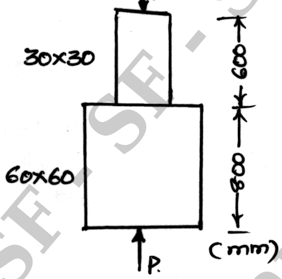

Fig Q1(b) **(06 Marks)**

c. A flat steel plate of trapezoidal section has a thickness of 20mm and taper uniformly from a width of 80mm to 30mm in a length of 500mm. What will be the elongation of the plate under an load of 200kN? E = 205GPa. **(06 Marks)**

OR

2 a. Two parallel walls, 8m apart, are to be stayed together by a steel rod of 30mm diameter with the help of washers and nuts at the ends. The steel rod is passed through the metal plates and is heated. When its temperature is raised to 90ºC, the nuts are tightened. Determine the pull in the bar when it is cooled to 24ºC if :

i) the ends do not yield
ii) the total yielding at the ends is 2mm

E = 205GPa and coefficient of thermal expansion of steel $\alpha_s = 11 \times 10^{-6}$/ºC **(08 Marks)**

b. The tangential (hoop) and longitudinal stresses in the plates of a cylindrical boiler of 2.2m diameter and 3.5m in length are 90MPa and 45MPa respectively. Determine the increase in the internal capacity. E = 205GPa, $\gamma = 0.3$. **(08 Marks)**

Module-2

3 a. Described the procedure for construction of Mohr's circle. **(06 Marks)**

b. The stresses on two perpendicular planes through a point in a body are 30MPa and 15MPa both tensile along with a shear stress of 25MPa. Find

i) the magnitude and direction of principal stresses.
ii) the planes of maximum shear stress
iii) the normal and shear stresses on the planes of maximum shearing stress. **(10 Marks)**

OR

4 a. A thick cylindrical shell of 200mm internal diameter is subjected to an internal fluid pressure of 7N/mm^2. If the permissible tensile stress in the shell material is 8N/mm^2 find the thickness of the shell. **(08 Marks)**

b. A thin cylinder, 2m long and 200mm in diameter with 10mm thickness is filled completely with a fluid, at the atmospheric pressure. If an additional $25000mm^3$ fluid is pumped in, find the longitudinal and hoop stress developed. Also determine the changes in diameter and length if $E = 2 \times 10^5 N/mm^2$ and Poisson's ratio = 0.3. **(08 Marks)**

Module-3

5 a. Define shear force, shear force diagram, Bending moment and Bending moment diagrams for beams. **(04 Marks)**

b. A 10-m long simply supported beam carries two point loads of 10kN and 6kN at 2m and 9m respectively from the left end. It also has uniformly distributed load of 4kN/m run for the length between 4m and 7m from the left end. Draw shear force and bending moment diagrams. **(12 Marks)**

OR

6 a. Define the terms : i) Pure bending ii) Bending stress. **(04 Marks)**

b. Enumerate the assumptions made in the theory of simple bending and derive an relation for simple bending for beams. **(12 Marks)**

Module-4

7 a. A solid steel shaft transmits 100kW at 150rpm. Determine the suitable diameter of the shaft if the maximum torque transmitted exceeds the mean by 20% in each revolution. The shear stress is not to exceed 60MPa. Also find the maximum angle of twist in a length of 4m of the shaft. G = 80GPa. **(06 Marks)**

b. A shaft transmits 280kW of power at 160rpm. Determine :
 i) the diameter of a solid shaft to transmit the required power
 ii) the inner and outer diameters of a hollow circular shaft if the ratio of the inner to outer diameter is 2/3.
 iii) The percentage saving in the material on using a hollow shaft instead of a solid shaft.
Take the allowable stress as 80MPa and the density of material $78kN/m^3$. **(10 Marks)**

OR

8 a. Derive a Euler's crippling load for a column when one end is fixed and other free. **(08 Marks)**

b. A 4-m long hollow alloy tube with inside and outside diameter as 36mm and 48mm respectively elongates by 3mm under a tensile force of 50kN. Determine the buckling load for the tube when it is used as column with both ends pinned and with a factor of safety 5. **(08 Marks)**

Module-5

9 a. Derive an expression for strain energy due to shear stresses. **(08 Marks)**

b. A hollow circular shaft of 2m length has an external diameter 100mm and a thickness of 10mm. If it is subjected to a torque of 10kNm, determine the strain energy stored in the shaft. Take G = 80GPa. **(08 Marks)**

OR

10 a. Explain :
 i) Maximum principal stress theory
 ii) Maximum shear stress theory. **(08 Marks)**

b. The stresses induced at a critical point in a machine component made of steel are as follows:
$\sigma_x = 100N/mm^2$, $\sigma_y = 40N/mm^2$, $\tau_{xy} = 80N/mm^2$.
Calculate the factor of safety by
 i) Maximum shear stress theory
 ii) Maximum normal stress theory. **(08 Marks)**

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