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TME-303

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 4071Roll No. **B. Tech.**

(SEM. III) EXAMINATION, 2007-08
STRENGTH OF MATERIAL

*Time : 3 Hours]**[Total Marks : 100*

- Note :** (1) *Answer all the questions.*
 (2) *Suitably assume data missing, if any.*

- 1 Answer any **three** of the following : **6×3=18**
- (a) State the generalized Hook's law and prove for an anisotropic elastic material the maximum number of elastic constants is 21 only. Also show that for isotropic materials it is 2.
- (b) State Castigliano's first and second theorems for strain energy. What are their uses ?
- (c) Derive an expression for strain energy in cantilever due to bending and shear under a concentrated edge load ?
- (d) Derive the equation of equilibrium in z-direction, by considering the equilibrium of an infinitesimal rectangular element of size $dx \ dy \ dz$ in the Cartesian co-ordinate system as

$$\frac{\partial \sigma_z}{\partial z} + \frac{\partial \tau_{xz}}{\partial x} + \frac{\partial \tau_{yz}}{\partial y} + \bar{z} = 0$$



- (e) At a point in a body, the displacement field is linear and is given by the following expressions. Find all the strains :

$$u = 0.07x + 0.05y + 0.01z$$

$$v = 0.01y - 0.04x$$

$$w = 0.02x + 0.02z$$

- 2 Answer any **three** of the following : 7×3=21

- (a) What are the assumptions made in the simple theory of bending ?
- (b) Derive the deflection equation for cantilever beam with uniformly distributed load.
- (c) Determine the dimensions of hollow shaft with a diameter ratio of 3:4, which is to transmit 60 kN at 200 rev/min. The maximum shear stress in the shaft is limited to 70 MN/m² and the angle of twist to 3.8° in a length of 4 m. For the shaft material, G=80 GPa.
- (d) Determine equivalent bending moment for the shafts subjected to combined bending and torsion.
- (e) In a thin circular tube show that the maximum shear stress is twice the average shear stress over the cross-section.

- 3 Answer any **three** of the following : 7×3=21

- (a) An open coiled spring carries an axial load W , show

$$\text{that the deflection is related to } W \text{ by } \delta = \frac{8Wn D^3}{G d^4} K$$

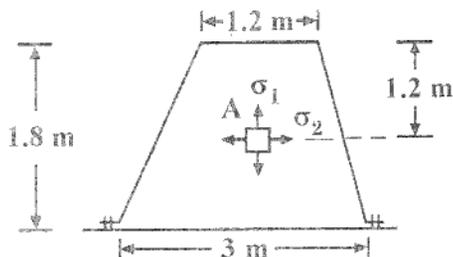
where K is a corrective factor which allows for the inclination of the coils, n = number of effective coils, D = mean coil diameter and d = wire diameter.

- (b) Explain middle quarta and middle third rules ? What are the importance of these rules for concrete sections ?
- (c) State the assumptions made during the Euler's formula for a strut with pin jointed ends. Derive the Euler's crippling load for such a strut - the general equations of bending and also the solution of the differential equation may be assumed.
- (d) A leaf spring is made of plates 50 mm wide and 8 mm thick. The spring has a span of 700 mm. Determine the number of plates required to carry a central load of 45 kN. The maximum allowable stress in the plates is 200 MPa. What is the maximum deflection under this load ?

4 Answer any **two** of the following : **10×2=20**

- (a) Derive the Lamé equations for the hoop and radial stresses in a thick cylinder subjected to an internal and external pressure and show how these may be expressed in graphical form.
- (b) A laminated thick walled hydraulic cylinder was fabricated by shrink-fitting a steel ($E = 200 \text{ GPa}$ and $\mu = 0.30$) jacket having an outside diameter 300 mm onto steel tube with an inside diameter of 100 mm and an outside diameter of 200 mm. The interference was 0.15 mm.
- (1) Determine the interfacial contact pressure
 - (2) Determine the maximum tensile stress in the laminated cylinder resulting from the shrink fit.

- (c) A truncated conical tank having the dimensions shown in Fig. is filled with water ($w = 1 \text{ gm/cm}^3$) Calculate the membrane stresses σ_1 and σ_2 for an element A of the wall situated as shown in the figure, if $t = .3 \text{ mm}$



- 5 Answer any **two** of the following : 10×2=20
- (a) Derive the equation to find the position of neutral axis for the following cross sections of curved beam :
- (1) Rectangular section
 - (2) Circular cross section.
- (b) What is shear centre ? Prove that the shear centre for a thin-walled balanced z section coincides with its centroid.
- (c) Determine the numerical value of the ratio $\sigma_{\max} / \sigma_{\min}$ for the case of plane bending of a curved beam having $2.5 \times 2.5 \text{ cm}$. square cross section if the radius of curvature of the centroidal axis is $R = 3.75 \text{ cm}$.