Printed pages: 03 Sub Code: NME302

Paper Id: 4 0 4 3 . Roll No

**B.TECH**
**(SEM III) THEORY EXAMINATION 2017-18**
**MECHANICS OF SOLIDS**

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

**Note: 1.** Attempt all Sections. If require any missing data: then choose suitably.

**SECTION A**

**1. Attempt *all* questions in brief.** **2 x10 = 20**

a. Define principal of superposition
b. Explain briefly the term 'shear stress' and 'complimentary stress' with proper illustrations.
c. What do you mean by "simple bending"? What are the assumptions made in the theory of simple bending?
d. A steel rod 15 mm in diameter and 2 m long is heated from 20°C to 120°C, E = 200 GPa and α =12 × 10-6 per °C. If the rod is not free to expand, find the thermal stress developed in steel rod?
e. Describe assumptions in Euler's column theory.
f. State Lame's theory.
g. What are the assumptions made in the derivation of stresses in a curved bar which is subjected to bending moments?
h. Write a note on Mohr's circle of stresses.
i. If the value of Poisson's ratio is zero, then it means that
(a) The material is rigid. (b) The material is perfectly plastic.
(c) There is no longitudinal strain in the material (d) The longitudinal strain in the material is infinite.
j. Show that for a beam subjected to pure bending, neutral axis coincides with the centroid of the cross-section.

**SECTION B**

**2. Attempt any *three* of the following:** **10x 3 = 30**

a. The figure 1. Below shows a steel rod of 25 $mm^2$ cross sectional area. It is loaded at four points, K, L, M and N. Assume Esteel = 200 GPa. Calculate the total change in length of the rod due to loading.

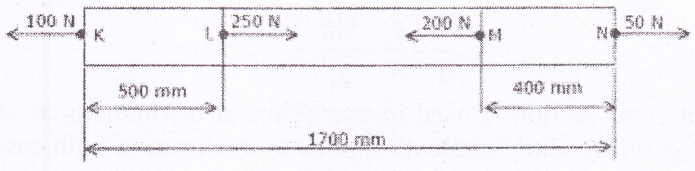


Figure 1

b. When an element is in a state of simple shear then prove that the planes of maximum normal stresses are perpendicular to each other and these planes are inclined at an angle of 45° to the planes of pure shear.

c. The principal stresses at a point in an elastic material are 22 N/mm$^2$ (tensile), 110 N/mm$^2$ (tensile), and 55 N/mm$^2$ (compressive).If the elastic limit in simple tension is 220 N/mm$^2$ and $\mu$= 0.3, then determine whether the failure of material will occur or not according to

(i) Distortion energy theory

(ii) Maximum strain energy theory

d. The rod PQ of length *L* and with flexural rigidity EI is hinged at both ends. For what minimum force *F* is it expected to buckle?

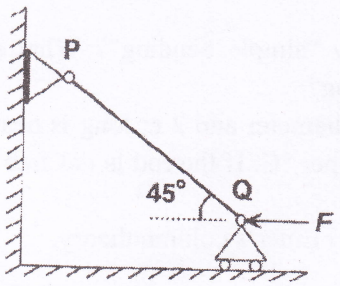


Figure2.

e. What largest internal pressure can be applied to a cylindrical tank 1.8 m in diameter and 14 mm wall thickness if the ultimate tensile strength of steel used is 467 MPa and a factor of safety of 7.

## SECTION C

**3. Attempt any *one* part of the following:** **10 x 1 = 10**

(a) A rectangular body is subjected to direct stresses in two mutually perpendicular directions accompanied by a shear stress. Derive the equation for normal stress and shear stress on an oblique plane inclined at an angle Θ with the plane of major direct stress.

(b) Derive an expression for the maximum strain energy theory when a body is subjected to principal stresses $\sigma_1$, $\sigma_2$, and $\sigma_3$.

**4. Attempt any *one* part of the following:** **10 x1 = 10**

(a) Derive the relation for a circular shaft when subjected to torsion as given below

$$\frac{T}{J}=\frac{\tau}{R}=\frac{G\theta}{L}$$

(b) A beam cross-section is used in two different orientations as shown in the given figure: Bending moments applied to the beam in both cases are same. Find the relation between the maximum bending stresses induced in cases (A) and (B)

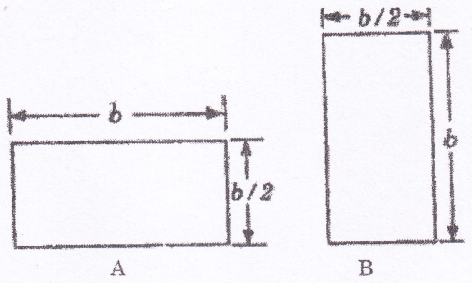


Figure 3

**5. Attempt any *one* part of the following:** **10 x 1 = 10**

(a) Find an expression for the maximum shear stress induced in the close-coiled helical spring.

(b) For the linear elastic beam shown in the figure 4, the flexural rigidity, EI is 781250 kN-m2 . When w = 10 kN/m, the vertical reaction $R_A$ at A is 50 kN. Find the value of $R_A$ for $w$ = 100 kN/m ?

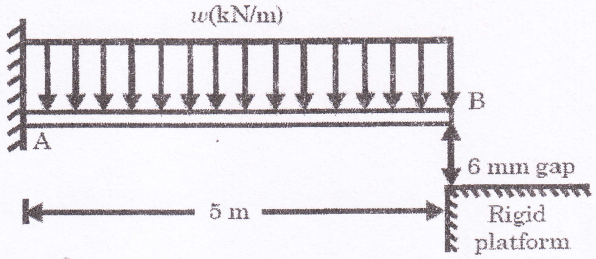


Figure 4.

**6. Attempt any *one* part of the following:** **10x 1 = 10**

(a) A hollow cast iron column of 30 cm external diameter and 23 cm internal diameter is used as a column 4 m long, with both ends hinged. Determine the Rankine's safe load with factor of safety 4. Take $\sigma_c$ = 564 MN/m$^2$ and a = $\frac{1}{1600}$.

(b) What do you mean by Lame's equations? How will you derive these equations?

**7. Attempt any *one* part of the following:** **10x1 = 10**

(a) Determine the location of neutral axis when a curved beam of trapezoidal section of bottom width 30 mm, top width 20 mm and height 40 mm is subjected to pure bending moment of +600 Nm. The bottom width is towards the center of curvature. The radius of curvature is 50 mm and beam is curved in a plane parallel to depth.

(b) Define and explain the terms: unsymmetrical bending and shear center.