Total No. of printed pages = 4

ME 181405

11/07/23

Roll No. of candidate | | | | | | | | | | |

2023

B.Tech. 4th Semester End-Term Examination

MECHANICS OF MATERIALS

New Regulation (w.e.f. 2017-18) & New Syllabus (2018-19)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question No. 1 and any *four* from the rest.

1. Select the correct answer : $(10 \times 1 = 10)$

(i) On a principal plane, the value of shear stress is

(a) zero (b) equal to principal stress

(c) twice the principal stress (d) half of principal stress

(ii) Deflection of a cantilever beam of length L under load W at the free end is given by

(a) $\frac{WL^3}{3EI}$ (b) $\frac{WL^3}{EI}$

(c) $\frac{WL^3}{8EI}$ (d) $\frac{WL^3}{48EI}$

(iii) Energy stored in a unit volume of an elastic body is called

(a) proof resilience (b) modulus of resilience

(c) strain energy (d) none of the above

(iv) The strength of a beam is directly proportional to its

(a) Length (b) Width

(c) Moment if Inertia (d) All of the above

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(v) The angle of helix in a practical close coiled spring is

(a) nearly zero (b) about 15°

(c) 10° to 15° (d) none of the above

(vi) If torque transmitted by a shaft of 10 cm diameter is 50000 Nm, Maximum shear stress induced is

(a) 260.50 MPa (b) 254.78 MPa

(c) 300.45 MPa (d) 340.38 MPa

(vii) The hoop stress in a thin cylinder of diameter D, length Z and thickness t when subjected to an internal pressure p is equal to

(a) $pD/4t$ (b) $pD/2t$

(c) $2pD/t$ (d) $4pD/t$

(viii) A higher value of flexural rigidity is indicative of

(a) Higher stiffness and lower deflection

(b) Lower stiffness and lower deflection

(c) Lower hardness and higher deflection

(d) None of the above

(ix) If bending moment induced in a rectangular cross-sectional bar of width 5 cm and height 10 cm is 10 kNm, maximum induced bending stress is

(a) 120 MP (b) 125 MP

(c) 130 MP (d) 150 MP

(x) Maximum bending moment for a simply supported beam of span L and central load W

(a) WL (b) $WL/2$

(c) $WL/4$ (d) $WL/8$

2. (a) How the state of stress at a point in space can be represented? What is principal stress and principal plane?

(b) Differentiate between the hydrostatic (spherical) and deviatoric (pure shear) state of a stress tensor. What is the effect of these two parts of a stress tensor on a body?

(c) Find graphically from Mohr's circle the principal stresses and the maximum shear stress for the plane stress case $\sigma_x = 500\ MPa$, $\sigma_y = -800\ MPa$, $\tau_{xy} = -300\ MPa$. Check your answer analytically. Find from Mohr's circle the stresses on a plane inclined at 22.5° to the given plan. (4+3+8)

3. (a) What is strain? Explain different types of strains with diagrams.

(b) The displacement field at a point is given below. Calculate the strain tensor.

$$\begin{bmatrix} u \\ v \\ w \end{bmatrix} = \begin{bmatrix} 0.10 & 0.05 & 0.04 \\ 0.03 & -0.02 & 0.03 \\ -0.04 & 0.04 & -0.02 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}.$$

(c) In a 3-element Delta Rosette, the strain readings are 1000, 720 and 600 respectively. Find the principal strains. (4+6+5)

4. (a) Deduce the expressions for stiffness and deflection for a closed coil helical spring.

(b) Define composite spring and its types.

(c) The stiffness of a closed coil helical spring is 1.5 N/mm under a maximum load of 60 N. The maximum shear stress in the spring is 125 N/mm^2 and its solid length is 5 cm. Find the diameters of the wire, the spring and the number of coils/turns, $G = 4.5 \times 104\ N/mm^2$. (5+4+6)

5. (a) What is equivalent bending moment and equivalent twisting moment for a rotating shaft subjected to combined bending and torsion? Deduce the expressions for equivalent bending moment and equivalent twisting-moment.

(b) Deduce the expressions for equivalent bending moment and equivalent twisting moment for a rotating staff.

(c) A solid circular shaft 0.10 m diameter is subjected to a bending moment M and twisting moment T. The maximum value of combined direct stress is $10^6\ N/m^2$. If the bending stress due to M is equal to shear stress due to T, calculate M and T. (5+5+5)

6. (a) Deduce the Curvature-Moment relation for beams.

(b) Calculate the maximum deflection and maximum slope for a cantilever beam with a point load W at the free end.

(c) Write a note on Castigliano's Theorem. (4+8+3)

7. (a) What kind of stresses are found in pressure vessels through which fluid is flowing under pressure? Explain with diagrams. What is shrunk cylinders and what is its advantage?

(b) The maximum permissible tensile stress in a cylinder of internal diameter 80 mm is 60 MN/m². Calculate the thickness needed for the cylinder to withstand an internal pressure of 12 MN/m².

(c) Discuss curved beams with examples. How they are analysed? (6+6+3)

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