Total No. of printed pages = 4

ME 181405

11/8/22

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

2022

B.Tech. 4th Semester End-Term Examination

MECHANICS OF MATERIALS

(New Regulation and New Syllabus)

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 answers : (10 × 1 = 10)

(i) Hook's law holds good up to

(a) yield point

(b) limit of proportionality

(c) elastic limit

(d) breaking point

(ii) Deflection of a cantilever beam is δ under load W. If width of the beam is halved, deflection becomes

(a) 2δ

(b) 4δ

(c) $\delta/2$

(d) $\delta/4$

(iii) When two springs (each of stiffness K) are in series, the equivalent stiffness will be

(a) K (b) K/2

(c) 2K (d) 1/K

(iv) The point of contraflexure is a point where

(a) shear force is zero

(b) shear force is maximum

(c) bending moment is maximum

(d) bending moment is zero

(v) The strain energy stored in a beam subjected to bending moment M is equal to

(a) $\int \frac{M^2 dx}{EI}$ (b) $\int \frac{M^2 dx}{2EI}$

(c) $\int \frac{M^2 dx}{3EI}$ (d) $\int \frac{M^2 dx}{4EI}$

(vi) A shaft with a circular cross-section is subjected to pure twisting moment. The ratio of maximum shear stress to the major principal stress is

(a) 2.0 (b) 0.5

(c) 1.0 (d) 0

(vii) Twisting couple in a shaft introduces in it

(a) bending moment (b) deflection

(c) shear stress (d) shear strain

(viii) 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

(ix) 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

(x) Maximum shear stress acts on a plane which is

(a) inclined at 90° to the principal plane

(b) inclined at 60° to the principal plane

(c) inclined at 45° to the principal plane

(d) none of the above

2. (a) What is the significance of an octahedral plan and the octahedral stresses on it? Give the expressions of octahedral stresses.

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

(c) Plane stress condition of an element is as follows: $\sigma_x = -60$ MPa, $\sigma_y = 50$ MPa, $\tau_{xy} = -70$ MPa.

(i) Find graphically from Mohr's circle the principal stresses and the maximum shear stress. Check your answer analytically.

(ii) Find from Mohr's circle the stresses on a plane inclined at 22.5°to the x-axis. (3+3+9)

3. (a) At a point p in a body, $\sigma_x = 30\text{kN/m}^2$, $\sigma_y = -10\text{kN/m}^2$, $\sigma_x = 10\text{kN/m}^2$, $\tau_{xy} = \tau_{yz} = \tau_{zx} = 10\text{kN/m}^2$. Find the normal and shear stresses on a plane that is equally inclined to all the three axes.

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

(c) At a point inside a body, the displacement field is linear as given below. Calculate the rectangular components of strain at (3, 1,2). (6+4+5)

$$\begin{vmatrix} u \\ v \\ w \end{vmatrix} = \begin{vmatrix} 4 & 2 & 5 \\ 3 & 7 & 1 \\ 1 & 4 & 8 \end{vmatrix} \begin{vmatrix} x \\ y \\ z \end{vmatrix}$$

4. (a) Derive the expression for deflection for a close coiled helical spring $\delta = \frac{64WnR^3}{Gd^4}$

(b) A truck weighing 30kN and moving at 5km/hr has to be brought to rest by a buffer. Find how many springs each of 18 coils will be required to store the energy of motion during a compression of 200 mm. The spring is made out of 25 mm diameter steel rod coiled to a mean diameter of 240 mm. (Take G=81370 N/mm²) (7+8)

5. (a) A shaft is required for an engine which indicates 746 kW at 800 rpm. The maximum twisting moment on the shaft is 1.5 times the mean twisting moment. The main bearings are 4500 mm apart and the shaft carries a flywheel of mass 60000 kg at the midpoint. The bending moment due to the flywheel is additional to that of the steam pressure which is 0.8 times the mean twisting moment. If maximum tensile stress is 65 MN/m², find the shaft diameter.

(b) Differentiate between rotating discs of uniform thickness and uniform strength.

(c) The disc of a turbine rotor is 0.5 m diameter and 45 mm thick at the outer radius and is keyed to a shaft of diameter 70 mm. If allowable stress is 250 MN/mm^2 at 8000 rpm, find the thickness at the shaft. Density of the rotor material is 7700 kg/m^3. (7+2+6)

6. (a) Calculate the maximum deflection and maximum slope for a simply supported beam with a central point load W.

(b) Determine the ratio of maximum and minimum values of stresses for a curved bar of rectangular cross-section in pure bending. Radius of curvature is 8 cm and depth of the beam is 6 cm. Locate the neutral axis. (8+7)

7. (a) Show the variation of σ_c and σ_r in a thick cylinder along its thickness due to external pressure p.

(b) A compound cylinder is made by shrinking a tube of 160 mm inner diameter and 20 mm thick over another tube of 160 mm external diameter and 20 mm thick. The radial pressure at the common surface after shrinking is 80. Find the final stress setup across the section when the compound cylinder is subjected to an internal pressure 600 N/cm^2. (5+10)