Code : 101506

B.Tech 5th Semester Exam., 2020
(New Course)

MECHANICS OF MATERIALS

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Choose the correct option (any *seven*) : 2×7=14

(a) The property of a body to return to its original shape after removal of the force is known as

(i) plasticity

(ii) elasticity

(iii) ductility

(iv) malleability

(b) The materials which have the same elastic properties in all directions are known as

(i) isotropic

(ii) brittle

(iii) homogeneous

(iv) hard

(c) Which point on the stress-strain curve occurs after yield plateau?

(i) Lower yield point

(ii) Upper yield point

(iii) Ultimate point

(iv) Breaking point

(d) Elastic limit is the point

(i) up to which stress is proportional to strain

(ii) at which elongation takes place without application of additional load

(iii) up to which if the load is removed, original volume and shapes are regained

(iv) None of the above

(e) What is the bending moment at end supports of a simply supported beam?

(i) Maximum

(ii) Minimum

(iii) Zero

(iv) Uniform

(f) Torsional sectional modulus is also known as

(i) polar modulus

(ii) sectional modulus

(iii) torsion modulus

(iv) torsional rigidity

(g) Which property is undesirable for shaft materials?

(i) High shear and tensile strength

(ii) Good machinability

(iii) High fatigue strength

(iv) Good castability

(h) The bending stress is

(i) directly proportional to the distance of layer from the neutral layer

(ii) inversely proportional to the distance of layer from the neutral layer

(iii) directly proportional to the moment of area

(iv) not dependent on the distance of layer from the neutral layer

(i) Which stress comes when there is an eccentric load applied?

(i) Shear stress

(ii) Bending stress

(iii) Tensile stress

(iv) Thermal stress

(j) Maximum slope in a cantilever beam of length L with a moment M at the free end will be

(i) $3ML/EI$

(ii) $2ML/EI$

(iii) ML/EI

(iv) None of the above

2. State of stress around a point on a thick bar is defined as

$\sigma_{xx} = 100$ MPa, $\sigma_{yy} = -86$ MPa, $\sigma_{zz} = 55$ MPa,

$\tau_{xy} = 60$ MPa, $\tau_{yz} = \tau_{zx} = 0$

Calculate principal stresses, principal planes, maximum shear stress and associated planes. 14

3. The bar having a diameter of 20 mm is fixed connected at its ends and supports the axial load P. If the material is elastic perfectly plastic as shown by the stress-strain diagram (Fig. 1), determine the smallest load P needed to cause segment CB to yield. If this load is released, determine the permanent displacement of point C. 14

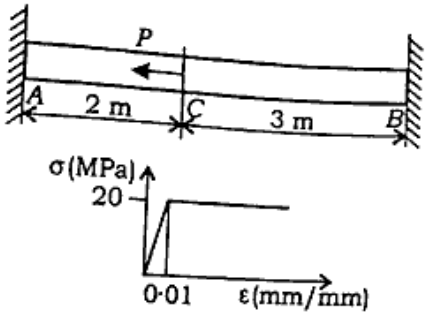

Fig. 1

4. A 2014-T6 aluminum tube having a cross-sectional area of 500 mm^2 is used as a sleeve for an A-36 steel bolt having a cross-sectional area of 300 mm^2. When the temperature is $T_1 = 30\ °C$, the nut holds the assembly in a snug position such that the axial force in the bolt is negligible. If the temperature increases to $T_2 = 100\ °C$, determine the force in the bolt and sleeve. Take $\alpha_{bolt} = 12 \times 10^{-6}/°C$, $\alpha_{sleeve} = 23 \times 10^{-6}/°C$, $E_{bolt} = 200$ GPa, $E_{sleeve} = 73$ GPa. 14

5. A motor is connected to a speed reducer by the tubular shaft and coupling. If the motor supplies 20 HP and rotates the shaft at a rate of 600 r.p.m., determine the minimum inner and outer diameters d_i and d_o of the shaft if $d_i / d_o = 0{\cdot}75$. The shaft is made from a material having an allowable shear stress of $\tau_{allow} = 12$ kPa. 14

6. Derive Euler's buckling formula for a column with one end clamped and other end free and obtain the effective length as well. Draw the free body diagram with buckled configuration. 14

7. If the wide-flange beam is subjected to a shear of $V = 20$ kN, determine the shear stress on the web at A (Fig. 2). Indicate the shear-stress components on a volume element located at this point. 14

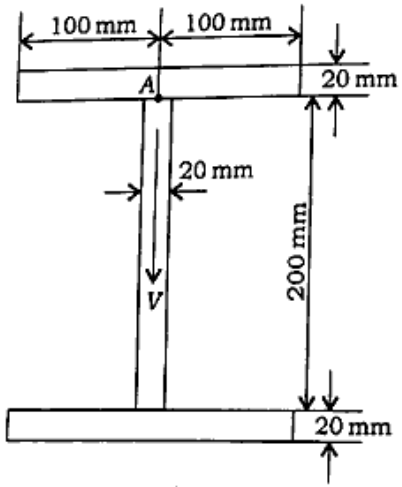

Fig. 2

8. Determine the maximum deflection of the simply supported beam using double integration method. The beam is made of wood having a modulus of elasticity of $E = 210$ GPa and cross-section 3 mm × 4 mm in dimension (Fig. 3). 14

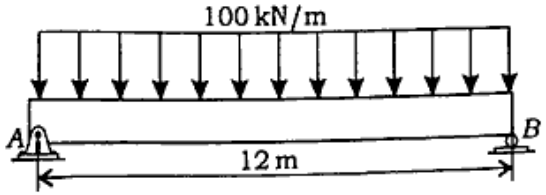

Fig. 3

9. Derive an expression for an equivalent bending moment M_e that, if applied alone to a solid bar with a circular cross-section, would cause the same maximum shear stress as the combination of an applied moment M and torque T. Assume that the principal stresses are of opposite algebraic signs. 14

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