KATHMANDU UNIVERSITY
End Semester Examination [C]
June/July 2024

Marks Scored:

Level : B.E.
Year : II

Course : CIEG 208
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date : 30 III 2024

SECTION "A"
[20Q. × 0.5 = 10 marks]

Choose and encircle the most appropriate answer.

1. A pin-jointed plane frame is unstable if (where m is number of members, r is reaction components and j is number of joints)
   a. $m + r = 2j$ b. $(m + r) > 2j$ c. $(m - r) < 2j$ d. $(m + r) < 2j$

2. What is the standard sign convention for a positive bending moment in beam analysis?
   a. Causes compression at the top fibers of the beam section
   b. Causes tension at the bottom fibers of the beam section
   c. Causes tension at the top fibers of the beam section
   d. Causes compression at the bottom fibers of the beam section

3. A plane element is subjected to a normal stress of 50 MPa and a shear stress of 30 MPa, then the approximate principal stresses will be.
   a. 64 MPa and -14 MPa b. 74 MPa and -24 MPa
   c. 84 MPa and -34 MPa d. 94 MPa and -44 MPa

4. In a composite bar, if the Young's modulus of one material is twice that of the other, and the lengths are equal, the stress in the stiffer material is:
   a. Half that of the other material b. Equal to that of the other material
   c. Twice that of the other material d. Four times that of the other material

5. According to Hooke's Law, stress is directly proportional to strain within the elastic limit. What is the proportionality constant called?
   a. Poisson's ratio b. Modulus of rigidity
   c. Bulk modulus d. Modulus of elasticity

6. A steel rod (coefficient of thermal expansion, $(\alpha = 12 \times 10 - 6/\circ C)$ of length 2 meters is fixed at both ends. If the temperature of the rod increases by 40°C, determine the thermal stress induced in the rod. The modulus of elasticity (E) for steel is 200 GPa. Assume the rod is not allowed to expand.
   a. 96 MPa b. 120 MPa c. 150 MPa d. 160 MPa

7. A steel bar of length 1.5 meters and diameter 30 mm is subjected to a compressive force of 80 kN. If the modulus of elasticity for steel is 210 GPa, what is the change in length due to compression?
   a. 0.25 mm b. 0.50 mm c. 0.75 mm d. 1.00 mm

8. The principal moments of inertia I_1 *and* I_2 for a given section are equal when:
   a. The section is symmetric about both principal axes
   b. The section is symmetric about one principal axis only
   c. The section is circular
   d. The product of inertia Ixy is zero

9. Which of the following statements about moment of inertia Ix *and* Iy for a rectangular section of width 'b' and height 'h' is **CORRECT**?

   $a. Ix = \frac{bh^3}{12}$ *and* $Iy = \frac{hb^3}{12}$ $\quad b. Ix = \frac{bh^3}{12}$ *and* $Iy = \frac{bh^3}{3}$

   $c. Ix = \frac{bh^3}{12}$ *and* $Iy = \frac{bh^3}{12}$ $\quad d. Ix = \frac{bh^3}{3}$ *and* $Iy = \frac{bh^3}{12}$

10. Which of the following statements about thin-walled vessels is **CORRECT**?
    a. Thin-walled vessels have large wall thickness compared to their diameter.
    b. Thin-walled vessels are mainly subjected to internal pressure.
    c. Thin-walled vessels are designed primarily for torsional loading.
    d. Thin-walled vessels have negligible stresses due to their thickness.

11. For a thin-walled cylinder of diameter $d = 0.5\,m$ and wall thickness $t = 5\,mm$, subjected to an internal pressure of $P = 1\,MPa$, the modulus of elasticity 'E' is around $200\,GPa$, the circumferential strain ϵ_θ is approximately:

    $a. \epsilon_\theta \approx 0.00011$ $\quad b. \epsilon_\theta \approx 0.00025$ $\quad c. \epsilon_\theta \approx 0.00035$ $\quad d. \epsilon_\theta \approx 0.00045$

12. Which of the following assumptions is **NOT** typically made in the theory of torsion for shafts?
    a. The shaft material is homogeneous and isotropic.
    b. The shaft cross-section remains circular after twisting.
    c. Torsional shear stress is uniformly distributed across the shaft cross-section.
    d. The length of the shaft is negligible compared to its diameter.

13. For a solid circular shaft with a diameter of 100 mm and length 2 m, subjected to a torque of 5000 Nm, the maximum shear stress (τ_{max}) is approximately:

    $a. \tau_{max}) \approx 31.87\,MPa$ $\quad b. \tau_{max}) \approx 100\,MPa$

    $c. \tau_{max}) \approx 318.67\,MPa$ $\quad d. \tau_{max}) \approx 500\,MPa$

14. In the analysis of composite beams (Flitched beams), the moment of resistance is primarily influenced by:
    a. Shear stress distribution.
    b. Torsional effects.
    c. Modulus of elasticity.
    d. Moment of inertia of the composite section.

15. Consider the following assumptions for pure bending theory:
    i. The material is heterogeneous and isotropic.
    ii. The stress is purely longitudinal and local effects near concentrated loads will be neglected.
    iii. The radius of curvature is large compared with the dimensions of the cross-section.

    Which of the above statements are correct?

    a. i and ii only $\quad$ b. ii and iii only $\quad$ c. i and iii only $\quad$ d. i, ii and iii

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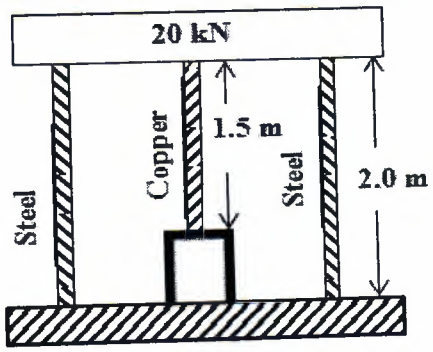
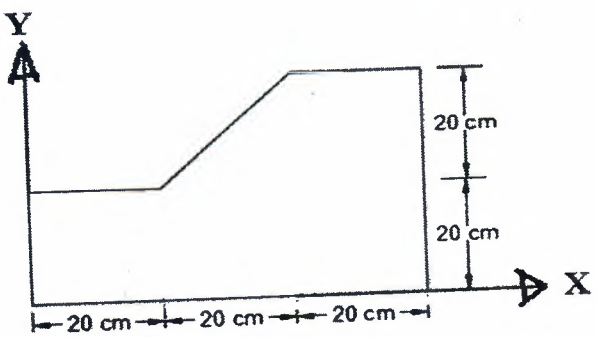
SECTION "B"

Attempt *ALL* Questions. Assume suitable data if necessary.

1. Derive an expression for normal and shear stresses on an inclined plane subjected to pure shear. Two steel rods and one copper rod each of 20 mm diameter together support a load of 20 kN as shown in figure. Find the stresses in rod. Take $Es = 2.05\ GN/m^2$.and $Ec = 1.10\ GN/m^2$. [3+4 =7]



2. Determine the orientation of principal axes and principal moment of inertia about centroidal axes of the section shown in figure. ***All dimensions are in cm.*** [6]

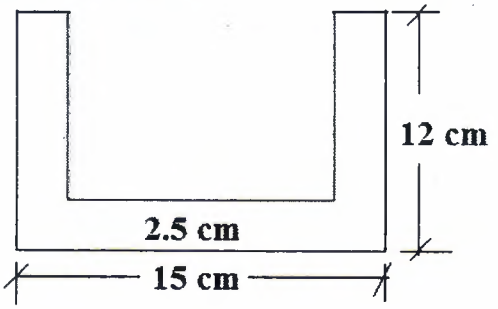


3. A solid circular shaft is to transmit 300 KW power at 100 r.p.m. If the shear stress is not to exceed 80 N/mm^2, find its diameter. What percentage saving in weight would be obtained if this shaft is replaced by a hollow one whose internal diameter equals to 0.6 of the external diameter, the length, the material and maximum shear stress being the same? [6]

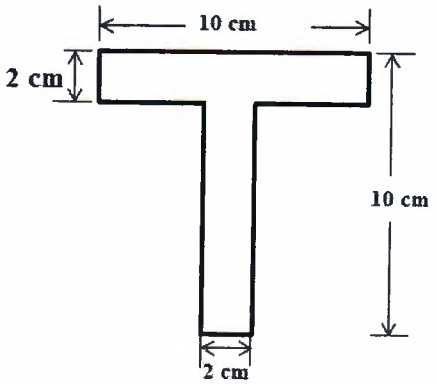
4. A boiler is subjected to an internal steam pressure of 2 N/mm^2. The thickness of boiler plate is 2.6 cm and permissible tensile stress is 120 N/mm^2. Find out the maximum diameter, when efficiency of longitudinal joint is 90% and that of circumferential joint is 40%. [3]

P.T.O.

5. A horizontal beam of the section shown in the figure is 3 m long and is simply supported at the ends. Find the maximum uniformly distributed load it can carry if the compressive and tensile stresses must not exceed 560 kg/cm^2 and 300 kg/cm^2 respectively. Draw a diagram showing the variation of stress over the mid span section of the beam. [7]



6. Determine the crippling load for a $T-$ section of dimensions $10cm\ X\ 10cmX\ 2cm$ and of length 5 m when it is used as strut with both of its ends hinged. Take Young's modulus, $E = 2X10^5\ N/mm^2$. [4]



7. Draw axial force, shear force and bending moment diagrams for the frame shown in figure, indicating the principal numerical values at salient point. [7]