Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS / B.TECH (CE) / SEM-3 / CE-304 / 2010-11

2010-11

STRUCTURAL MECHANICS

Time Allotted : 3 Hours　　　　　　　　　*Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words

as far as practicable.

### GROUP – A

(Multiple Choice Type Questions)

1.　Choose the correct alternatives for any *ten* of the following :

$$10 \times 1 = 10$$

　　i)　Factor of safety as used by designers is the ratio of

　　　　a)　Stress to strain

　　　　b)　Lateral contraction to axial elongation

　　　　c)　Elongation to original length

　　　　d)　Ultimate stress to working stress.

　　ii)　For a statistically determinate structure, equilibrium equation is

　　　　a)　$\sum V = 0$　　　　b)　$\sum M = 0$

　　　　c)　$\sum H = 0$　　　　d)　All of these.

iii) Strain energy stored in a body is

    a) Kinetic Energy   b) Potential Energy

    c) Thermal Energy   d) none of these.

iv) In Mohr's Circle, maximum ordinate in positive direction represent

    a) Maximum principal stress

    b) Minimum principal stress

    c) Maximum shear stress

    d) All of these.

v) In case of thin cylinder subjected to internal pressure, ratio of hoop stress to longitudinal stress is

    a) $\dfrac{1}{2}$ b) 2

    c) 1   d) $\dfrac{1}{\sqrt{2}}$.

vi) Effective length for axially loaded long column (used in Euler's theory) when both end fixed is

    a) $L = 1$ b) $L = 1/2$

    c) $L = 21$ d) none of these.
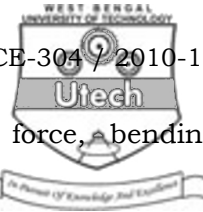
vii) In a beam, relation between shear force, bending moment and axial dimension is given by

   a) $\dfrac{dM}{dx} = -F$ b) $\dfrac{dM}{dx} = -M$

   c) $\dfrac{dM}{dx} = -x^2$ d) none of these.

viii) Proof stress for material corresponds to a strain

   a) 0 1%   b) 0 2%

   c) 0 3%   d) 0 4%.

ix) Volumetric strain is

   a) the product of strain in 3 mutually perpendicular directions

   b) the sum of strain in 3 mutually perpendicular directions

   c) the ratio of original volume by change in volume

   d) the ratio of elastic modulus and modulus of rigidity.

x) The centre of gravity of a plate girder made with I-section, the plate being fitted with top flange, lies

   a) at the centre of the web

   b) below the centre of the web

   c) above the centre of the web

   d) at the centre of top flange.
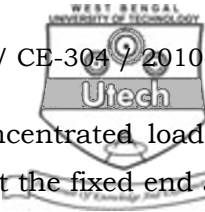
xi) For a cantilever beam carrying a concentrated load at the free end the deflection and slope at the fixed end are as follows :

    a) both deflection and slope are zero

    b) both deflection and slope are not zero

    c) deflection is not zero but slope is zero

    d) deflection is zero but slope is not zero.

xii) If the width of a rectangular section of width b and depth d is doubled, the flexural rigidity of the section will

    a) not be change

    b) reduce to half value

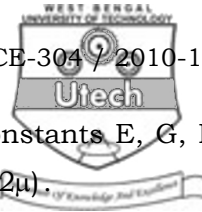   c) increases to double value

    d) increases to triple value.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.   3 × 5 = 15

2. For circular bar with diameter varying uniformly from d_1 to d_2, prove that $\Delta = \dfrac{4PL}{\pi E d_1 d_2} = \dfrac{PL}{AE}$, $A = \dfrac{\pi}{4} d_1 d_2$.

3. Establish the relationship between elastic constants E, G, K and Poisson's ratio μ is $E = 2G(1 + \mu) = 3K(1 - 2\mu)$.

4. What are the assumptions made in Euler's theory ?

5. A solid round bar of 8 cm in diameter and 3 5 m long is used as column, both ends of the column is fixed. Find the safe compressive load using Euler's formula.

6. A simply supported beam of span 4 5 m and section 350 mm × 400 mm is having UDL of intensity 20 kN/m and a point load of 50 kN at the mid-point. Draw the S.F. and B.M. diagram of the system. Take $E = 2 \times 10^4 \, N/mm^2$.
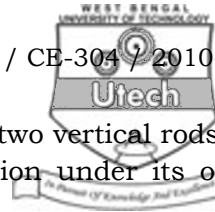
GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. Draw the bending moment and shear force diagrams for the following beam :
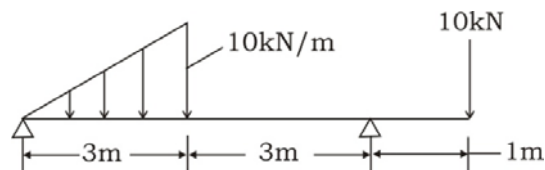
8. A rigid bar *AB*, 9 m long, is suspended by two vertical rods at its ends and hangs in a horizontal position under its own weight as shown below :

   The rod at *A* is of brass; length 3 m, cross-sectional area 10 cm², modulus of elasticity 1×10^5 MPa. The rod at *B* is steel, length 5 m, cross-sectional area 4·55 cm², modulus of elasticity 2×10^5 MPa. At what distance *x* from *A* may a vertical load '*P*' be applied if the bar is to remain horizontal after the load is applied ?
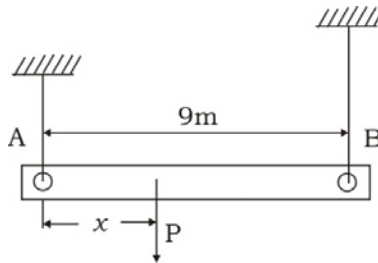
9. A symmetrical I-section has an overall depth of 500 mm. Each of the two equal flanges has a width of 200 mm and a thickness of 25 mm. The web is 20 mm thick and has a depth of 450 mm. If permissible shear stress of the material is 110 MPa, what is the safe value of maximum shear force the section can resist ? With this maximum shear force in the section draw the distribution of shear stress over the cross-section. Also calculate the percentage of shear force resisted by the web of the I-section.

10. A solid circular shaft is to transmit a twisting moment of 4·5 kN-m. If the maximum shear stress is not to exceed 80 MPa and the angle of twist is not to exceed one degree in 20 times diameter of its length, determine the diameter of the shaft if the modulus of rigidity of the material is 8×10^4 MPa.
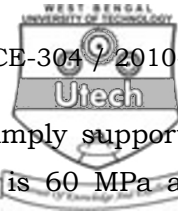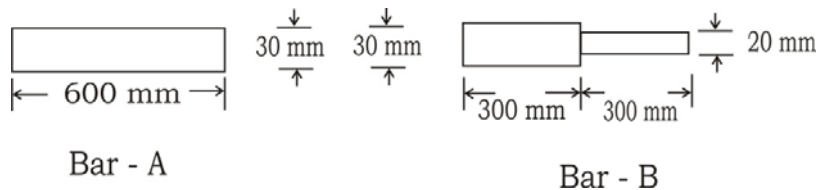
11. In an element at a point in the web of a simply supported girder the horizontal bending tensile stress is 60 MPa and shear stress at the same point is 30 MPa (left-up and right-down type). Calculate

(a) principal stresses (b) maximum shearing stress, (c) the tensile stress which, when acting alone would produce the same maximum shear stress, also, (d) the shear stress which, when acting alone produces the same major principal stress.

12. Two bars 'A' and 'B' made of same material, are as shown below :

Assuming that both the bars are subjected to gradually applied tensile forces, find the ratio of strain energy stored in bar A to that in B if the maximum stress produced in both the bars is same.

Bar - A   Bar - B

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