Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.Tech (CHE)/SEM-5/CHE-501/2011-12
2011
MACHINE DESIGN

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 × 1 = 10

   i) The material which has same elastic properties in all directions is called
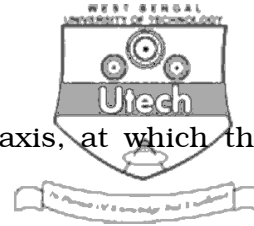
      a) ideal material   b) uniform material

      c) isotropic material   d) none of these.

   ii) The polar moment of inertia of a solid circular shaft of diameter D is given by

      a) $\dfrac{\pi}{32} D^3$ b) $\dfrac{\pi}{32} D^4$

      c) $\dfrac{\pi}{64} D^3$ d) $\dfrac{\pi}{64} D^4$.

   iii) In rivet joint, when the rivets in various rows are opposite to each other, the joint is said to be

      a) chain riveted   b) zigzag riveted

      c) diamond riveted   d) none of these.

5006   [Turn over

iv) The neutral axis of a section is an axis, at which the bending stress is

    a) minimum   b) zero

    c) maximum   d) infinity.

v) The length of *V*-belt is designated by

    a) inside length

    b) outside length

    c) length at the centre of belt

    d) none of these.

vi) A knuckle pin may fail in

    a) shear mode   b) bending mode

    c) crushing mode   d) none of these.

vii) The endurance limit of a material can be improved by

    a) heat treatment

    b) knurling

    c) polishing

    d) introducing radial stress.

viii) The equivalent bending moment under combined action of bending moment *M* and torque *T* is

    a) $\sqrt{M^2 + T^2}$ b) $\dfrac{1}{2}\sqrt{M^2 + T^2}$

    c) $M + \sqrt{M^2 + T^2}$ d) $\dfrac{1}{2}\left[M + \sqrt{M^2 + T^2}\right]$.

ix) Cylindrical pressure vessel in horizontal condition is generally supported by

    a) lug support   b) skirt support

    c) saddle support   d) guy support.

x) For brittle material which theory is mostly applicable ?

    a) Maximum shear stress theory

    b) Maximum normal stress theory

    c) Coulomb-Mohr theory

    d) Distortion energy theory.

xi) Thin shell means

    a) wall thickness of the shell (t) is less than $1/10$ of the diameter of the shell (d)

    b) wall thickness of the shell (t) is greater than $1/10$ of the diameter of the shell (d)

    c) wall thickness of the shell (t) is equal to the diameter of the shell (d).

xii) The maximum value of the pitch of rivets for a longitudinal joint of a boiler as per I.B.R. is

    a) $p_{max} = c * t + 41·28$ mm

    b) $p_{max} = c * t$ mm

    c) $p_{max} = c/t + 1·28$ mm

    d) $p_{max} = c + t + 41·28$ mm

where t = thickness of the shell plate in mm

          c = constant.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. a) State Hooke's law. Define elastic modulus from the law.

    b) A reinforced concrete circular section of 50000 mm^2 cross-sectional area carries six reinforcing bars whose total area is 500 mm^2. Find the safe load, the column can carry, if the concrete is not to be stressed more than $3·5$ MPa. Take the ratio of elastic modulus for steel and concrete as 18. $2 + 3$

3. Prove the relation $\dfrac{\tau}{R} = \dfrac{C\theta}{l}$, notations bear their usual significance.

4. a) Show that the power transmission by a solid circular shaft depends on the r.p.m. and torque applied to the one end of the shaft.

   b) A circular shaft of 100 mm diameter is transmitting 120 kW at 150 r.p.m. Find the intensity of shear stress in the shaft. $2 + 3$

5. a) Describe the failures in the riveted joints.

   b) A single riveted lap joint is made in 10 mm thick plates with 20 mm diameter rivets. Determine the strength and efficiency of the joint, if pitch of the rivets is 50 mm ? $2 + 3$

6. a) "Long column buckles whereas short column crushes under the application of the critical load." Explain.

   b) Find out the slenderness ratio for a long column made of mild steel with two ends hinged. Assume that σ_C (crushing stress) for mild steel not to exceed 320 MPa and the elastic modulus of mild steel is 200 GPa. $2 + 3$
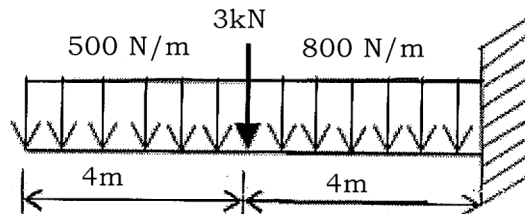
GROUP – C

(**Long Answer Type Questions**)

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

7. a) Draw the SF and MB diagrams for the cantilever beam shown in figure.

   b) A 500 mm long bar has rectangular cross-section 20 mm × 40 mm faces. This bar is subjected to

   i)   40 kN tensile force on 20 mm × 40 mm faces

   ii) 200 kN compressive force on 20 mm × 500 mm faces and

   iii) 300 kN tensile force on 40 mm × 500 mm faces.

   Find the change in volume if $E = 2 \times 10^5$ N/mm^2 and μ = 0·3.   10 + 5

8. a) A rectangular column of wood 3 m long, carries a load of 300 kN. Determine whether or not a section of 200 mm × 150 mm will be able to carry this load if a factor of safety is 3 to be used, assuming Euler's formula is applicable.

   Given E = 12·5 GPa and permissible stress is 12 MPa.

   If this section will not be able to carry this load, design a square section to do so.
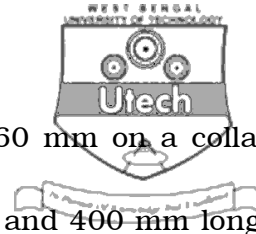
b) A 100 N load falls from a height of 60 mm on a collar attached to a bar of 30 mm diameter and 400 mm long. Find the instantaneous stress and extension produced in the bar. Take $E = 2 \times 10^5$ N/mm^2. 10 + 5

9. a) A long straight tube 76 mm internal diameter and 2·5 mm thick is subjected to an internal pressure of 5·6 N/mm^2. Consider it as a thin cylinder. If the tube is subjected to a twisting moment of 70 Nm and elastic limit stress $= 282$ N/mm^2, determine the factor of safety by the

   i) maximum principal stress theory and

   ii) maximum shear stress theory.

   b) Distinguish between thin and thick pressure vessels. From Lame's equation give the expression of tangential and radial stress in terms of internal pressure, internal diameter and external diameter. 10 + 5

10. a) Two 100 mm diameter shafts are to be connected by means of flanges with 20 mm diameter bolts equally spaced in a circle of diameter 200 mm. If the maximum shear stress in the shaft is not to exceed 75 MPa and the average shear stress in the bolts is not to exceed 60 MPa, determine the no. of bolts.

b) If the key is 20 mm wide, determine its length assuming the key is rectangular. 10 + 5

11. Write short notes on any *three* of the following : 3 × 5

a) Rankine's column formula

b) Soderberg criteria

c) Difference between riveted joint and welded joint

d) Knuckle joint

e) Hoop stress.