Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS / B.TECH (CHE) / SEM-5 / CHE-501 / 2010-11

2010-11

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 the following : $10 \times 1 = 10$

   i) A solid shaft of diameter D transmits the torque equal to

   a) $\frac{\pi}{32}\tau D^3$ b) $\frac{\pi}{64}\tau D^3$

   c) $\frac{\pi}{16}\tau D^3$ d) $\frac{\pi}{8}\tau D^3$.

   ii) Polar moment of inertia of a solid circular shaft of diameter D is equal to

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

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

iii) In the assembly design of shaft, pulley and key

a) pulley is made the weakest

b) key is made the weakest

c) key is made the strongest

d) all the three are designed for equal strength.

iv) 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 = const.

v) Hooke's law is applied to

a) Homogeneous body b) Black body

c) Gray body d) none of these.

vi) Euler's formula is applicable to

a) only short column

b) only very long column

c) long and short columns

d) moderately long column.

vii) A knuckle joint is used to connect two rods which lie in

a) same plane

b) different planes

c) rods are fixed in one direction

d) both (a) and (b).

viii) The maximum shear stress in a thin cylindrical shell of diameter d, length L and thickness t, when subjected to an internal pressure p is equal to

a) $\frac{pd}{4t}$ b) $\frac{pd}{8t}$

c) $\frac{pd}{2t}$ d) $\frac{pd}{t}$.

ix) When a thick cylinder is subjected to internal fluid pressure p_i, the maximum value of circumferential stress is

a) $\frac{2p_iR_i^2}{R_O^2 - R_i^2}$ b) p_i

c) 0 d) $\left(\frac{R_O^2 + R_i^2}{R_O^2 - R_i^2}\right) \times p_i$.

x) Poisson's Ratio means

a) linear strain / lateral strain

b) lateral strain / linear strain

c) linear stress / lateral strain

d) lateral stress / linear stress.

GROUP – B

(Short Answer Type Questions)

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

2. A hollow shaft of external diameter 120 mm transmits 300 kW power at 200 r.p.m. Determine the maximum internal diameter if the maximum stress in the shaft does not exceed 60 N/mm^2.

3. Determine the thickness of a 120 mm wide uniform plate for safe continuous operation if the plate is to be subjected to a tensile load that has a maximum value of 250 kN and a minimum value of 100 kN. The properties of the plate material are as follows :

   Endurance limit stress = 225 MPa, Yield point stress = 300 MPa, F.S. based on yield point may be taken as 1.5.

4. A cotter joint has to be designed to connect two mild steel rods. The joint is subjected to a 20 kN tensile force. The tensile and crushing strengths are 60 N/mm^2 and 75 N/mm^2, respectively. Find the diameter of the connecting rod and the thickness of the cotter. Assume $t = 0.25d_1$, where t is the thickness and d_1 is the slot diameter.

5. From the fundamental stress analysis in thin-walled pressure vessel prove that $\frac{\sigma_1}{r_1} + \frac{\sigma_2}{r_2} = \frac{p}{t}$. Notations bear the usual significance.

6. An aluminium bar is 2 m long and has 2.5 cm × 2.5 cm cross-section over 1.2 m of its length and a 2.5 cm diameter circular cross-section over other 0.8 m. How much will the bar elongate under a tensile load P = 625 kN, if the modulus of elasticity = 75 GPa.

GROUP – C

(Long Answer Type Questions)

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

7. a) A steel rod is subjected to a reversed axial load of 180 kN. Find the diameter of the rod of a factor of safety of 2. Neglect column action. The material has an ultimate tensile strength of 1070 MPa and yield strength of 910 MPa. The endurance limit in reversed bending may be assumed to be one-half of the ultimate tensile strength. Other correction factors may be taken as follows :

For axial loading = 0.7, for machined surface = 0.8, for size = 0.85, for stress correction = 1.0.

b) Explain Soderberg criteria. 9 + 6

8. a) Design a clamp coupling to transmit 30 kW at 100 r.p.m. The allowable shear stress for the shaft and key is 40 MPa and the number of bolts connecting the two halves is six. The permissible tensile stress for the bolts is 70 MPa. The coefficient of friction between the muff and the shaft surface may be taken as 0.3.

b) Explain torsional rigidity and the lateral rigidity of the shaft. 9 + 6

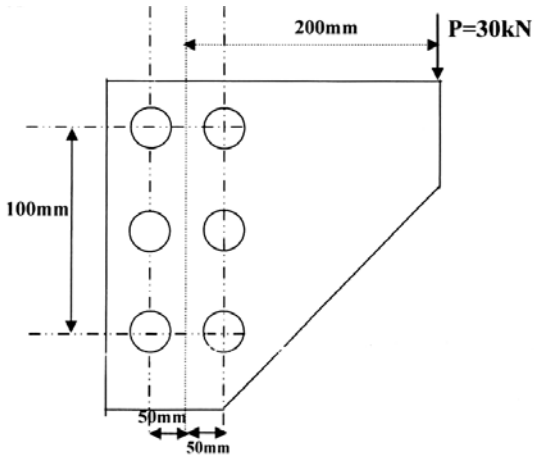
9. a) A leather belt 120 mm wide and 6 mm thick transmits power from a pulley of diameter 750 mm at 500 r.p.m. Angle of lap for smaller is 150°, coefficient of friction is 0.3, mass of belt 1 Mg/m^3 and the maximum permissible stress is 2.75 MPa. Find the maximum power that can be transmitted.

b) Describe the classification of pressure vessels.

c) Compare rigid coupling and flexible coupling. 8 + 3 + 4

10. a) Explain the different failures of rivet joints with diagram.

b) A vertical load of 30 kN is applied on a riveted joint as shown below. The rivets are 18 mm in diameter. Find the maximum shear stress induced in the rivet. If the thickness of the plate is 15 mm, determine the crushing stress of the rivet.



5 + 10

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

a) Endurance limit

b) Welded joint

c) Slenderness ratio

d) Mechanism of fatigue failure

e) Thin cylindrical pressure vessel.

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