Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech/CHE (N)/SEM-5/CHE-504B/2012-13

2012
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 : $10 \times 1 = 10$

   i) In a multiple V-belt drive, when a single belt is damaged, it is preferable to change the complete set to
      a) Reduce vibration
      b) Reduce slip
      c) Ensure uniform loading
      d) Ensure proper alignment.

   ii) If a shaft made from ductile material is subjected to combined bending and twisting moments, calculations based on which of the following, failure theories would give the most conservative value ?
      a) Maximum principal stress theory
      b) Maximum shear stress theory
      c) Maximum strain energy theory
      d) Maximum distortion energy theory.

iii) The bolts in a rigid flange coupling connecting two shafts transmitting power are subjected to

a) Shear force and bending moment

b) Axial force

c) Torsion

d) Torsion and bending.

iv) Pressure vessels that are to contain poisonous or toxic substances are classified as

a) Class I b) Class II

c) Class III d) Class IV.

v) A metal pipe of 1.0 m diameter contains a fluid having pressure of 10 kg/cm^2. If the permissible tensile stress in the metal is 200 kg/cm^2 then the thickness of pipe metal would be

a) 5 mm b) 10 mm

c) 20 mm d) 25 mm.

vi) Two shafts A and B are made of the same material. The diameter of B is twice that of A. The ratio of power transmitted by shaft A to that of shaft B is

a) 1/2 b) 1/4

c) 1/8 d) 1/16.

vii) Given that T_1 and T_2 are the tensions on the tight and slack sides of the belt respectively. The initial tension of the belt taking into account centrifugal tension T_c, is equal to

a) $(T_1 + T_2 + T_c)/3$ b) $(T_1 + T_2 + 2T_c)/2$

c) $(T_1 + T_2 + 3T_c)/3$ d) $(T_1 + T_2 - 2T_c)/2$.

viii) Strain energy stored in a body of volume V subjected to uniform stress S is

a) SE/V b) SE^2/V

c) SV^2/E d) $S^2V/2E$.

ix) The modulus of elasticity for a material is 200 GN/m^2 and Poisson's ratio is 0.25. What is the modulus of rigidity ?

a) 80 GN/m^2 b) 125 GN/m^2

c) 250 GN/m^2 d) 320 GN/m^2.

x) When hole of diameter d is punched in a metal of thickness t, the force required to punch the hole is equal to

a) $dt\,\tau_{ult}$ b) $\pi dt\,\tau_{ult}$

c) $\pi/4d^2\,\tau_{ult}$ d) $\pi/4d^2t\,\tau_{ult}$

xi) If fatigue loading stress ratio r, which is the minimum stress to maximum stress, the amplitude ratio can be

a) $(1-r)/(1+r)$ b) $(1+r)/(1-r)$

c) $(1-r/1+r)^{1/2}$ d) $(1+r/1-r)^{1/2}$.

GROUP – B

(Short Answer Type Questions)

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

2. Draw the Shear Force (S.F.) and bending moment (B.M.) diagrams for the beam loaded as shown in Fig. 1. State the position and magnitude of maximum bending moment.

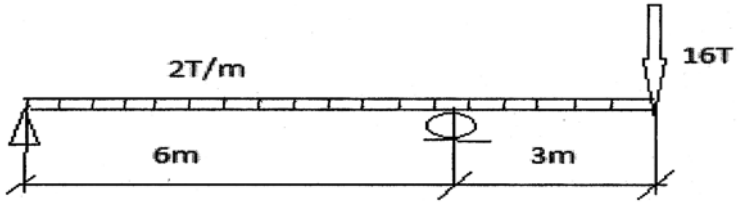

Fig. 1

3. Prove the relation $M/I = \sigma/y = E/R$. Notations have their usual significance.

4. What is the function of a key ?

   A 100 mm diameter shaft rotating at 100 rpm transmits 224 kW. Power is taken off through a gear whose hub is 200 mm long. The key is made of steel having ultimate shearing stress of 350 N/mm^2. Using a factor of safety of 5, determine the width and thickness of desired key.

5. What do you mean by stress concentration ? How can the stress concentration in a component be reduced ?

6. A rolled steel joint of I-section has dimensions (in mm) as shown in Fig. 2. The beam carries a UDL of 40 kN/m run on a span of 10 m. If the stress of the material is 250 N/mm^2, justify whether the beam is suitable or not.

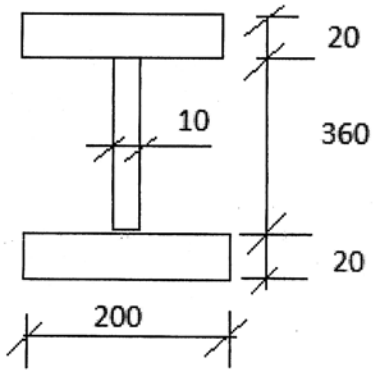

Fig. 2

GROUP – C

(Long Answer Type Questions)

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

7. The bracket as shown in Fig. 3 is to carry a load of 60 kN. Determine the size of the rivet if the shear stress of the rivet material does not exceed 80 MPa.

Assume all the rivets are of same size.

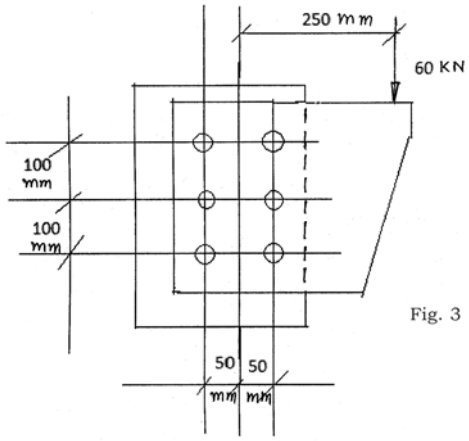

Fig. 3

8. A overhung shaft carries a 1000 mm diameter pulley whose centre is 250 mm from the centre of the bearing (Fig. 4). The weight of the pulley is 600 N and the angle of lap belt is 180°. The pulley is driven by a motor placed below it at an angle of 45°. If the permissible tension in the belt is 2500 N and coefficient of friction is 0.3, determine the size of the shaft. Assume permissible shear stress of the shaft material as 50 MPa, shock and fatigue factors for torsion and bending as 2 and 1.5 respectively.

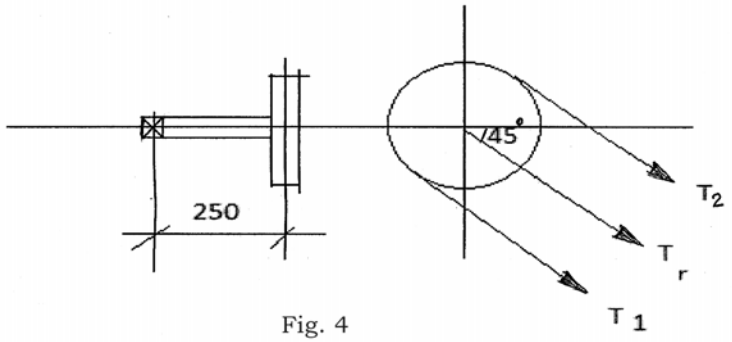

Fig. 4

9. Distinguish between thin and thick pressure vessels. A hydraulic control for a straight line motion utilizes a spherical pressure tank(A) which is connected to a working cylinder B. A pump maintains a pressure of 3.5 N/mm^2 in the tank.

   i) If the diameter of the tank 750 is mm, allowable tensile stress of the material is 60 MPa, find the thickness of the tank. Take welding joint efficiency as 80%.

   ii) Assuming a pressure drop of 0.25N/mm^2 between the tank and cylinder, determine the diameter of the piston to produce an operating force 25kN. Assume 10% loss of operating force due to friction between cylinder wall and piston.

iii) Determine the wall thickness of the cylinder assuming a permissible stress of cylinder material as 25MPa.

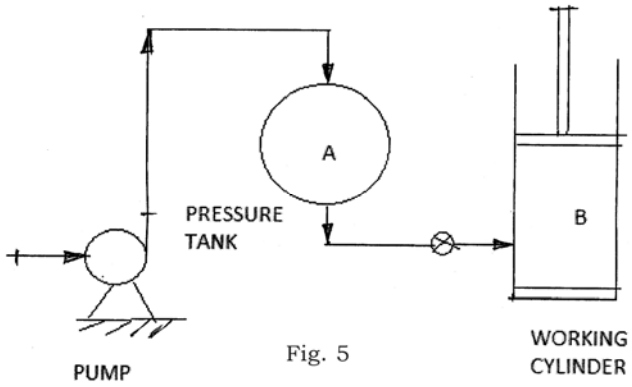

Fig. 5

10. A hot rolled steel shaft is subjected to a torsional load that varies from 300 Nm clockwise to 100 Nm anti-clockwise as an applied bending moment at a critical section varies from +400Nm to –200Nm. The shaft is of uniform cross-section and no keyway is present at the critical section. Determine the required shaft diameter.

Given, σ_{ult}= 560MPa, σ_{yp}= 420MPa, $\sigma_e = 0.5\sigma_{ult}$, $\tau_y = 0.5\ \sigma_{yp}$

Factor of safety = 1.5

Load correction factor

= 0.6 for variable twisting moment

= 1.0 for variable bending moment.

Surface correction factor = 0.85, Size correction factor = 0.85, Fatigue stress concentration factor = 1.4.