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H-ME-551BE (Vth Semester)

(New Course) Examination, 2017

Branch : Mechanical Engineering

MACHINE DESIGN - I

Time Allowed : Four Hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : (1) Design data book of PSG and ISI data sheets are allowed in the examination.

(2) The duration of the paper is 4 (four) hours.

(3) All question carries equal marks. Attempt any two parts from (a), (b) and (c) in each question.

(4) Assume any data if missing.

Q. 1. (a) Explain different types of theories of failure ?

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(b) Explain Soderberg and Goodman line.

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(c) A spherical pressure vessel, with 500 mm inner diameter, is welded from steel plates. The welded joints are sufficiently strong and do not weaken the vessel. The plates are made from cold drawn steel 20C8 ($S_{ut} = 440$ N/mm² and $S_{yt} = 242$ N/mm²). The vessel is subjected to internal pressure, which varies from 0 to 6 N/mm². The expected reliability is 50% and the factor of safety is 3.5. The vessel is expected to withstand infinite number of stress cycles. Calculate the thickness of the plates.

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Q. 2. (a) Design a cotter joint to support a load carrying from 30 kN in compression. The following allowable stresses may be used for the material of the joint used. Tensile stress = compressive stress = 50 MPa; shear stress = 35 MPa and crushing stress = 90 MPa.

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(3)

- (b) A shaft is required to transmit 15 kW at 400 rpm. Select a suitable key of rectangular cross-section, if the hub length is 50 mm. Take allowable shear and crushing stresses for the material used as 70 MPa and 140 MPa respectively. 8

- (c) A CI flange coupling transmits 10.0 kW at 200 rpm. The shaft diameter is 50 mm. The flanger of the coupling are bolted with 6 bolts of M12 \times 1 at a bolt circle diameter of 300 mm. The web thickness of flange is 20 mm. Hub diameter is 120 mm, key used is 10 \times 8 \times 36. Compute : 8

- (i) Shear stress induced in shafts, bolts, flange and key.
(ii) Crushing stress induced in the key.

- Q. 3. (a) Determine the diameter of the solid shaft required to transmit 60 kW at 1000 rpm. The allowable shear stress may be taken as 80 MPa. Replace the solid shaft with a hollow one, assuming a diameter ratio of 0.75, made of the same material and factor of safety. As a result of replacement, determine : 8

(4)

- (i) Percentage of reduction in weight assuming same length of both shafts.
(ii) The ratio of torsional stiffness of the hollow shaft to that of solid shaft.

- (b) A shaft is supported by two bearing placed 1 m apart. A 600 mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2.25 kN. Another pulley 400 mm diameter is placed 200 mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is 180° and $\mu = 0.24$. Determine the suitable diameter for a solid shaft, allowing working stress of 60 MPa in tension and 40 MPa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley. 8

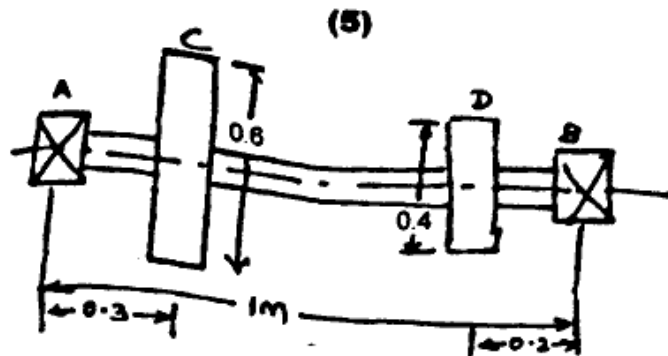


Fig. 1

(e) The following data is given for a single driving plate clutch :

Power = 110 kW; Speed = 1250 r.p.m.

Outer diameter of the contact surface = 300 mm, Coefficient of friction = 0.4

- Assuming a uniform pressure of 0.17 N/mm^2 ; determine the inner diameter of the friction surfaces.
- Assuming the same dimensions and the same total axial thrust, determine the maximum torque that can be transmitted and the maximum intensity of pressure when uniform wear conditions have been reached.

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- Q. 4. (a) The steel plate subjected to a force of 5 kN and fixed to a channel by means of three identical bolts is shown in Fig. 2. The bolts are made from plain carbon steel ($\sigma_{yt} = 380 \text{ N/mm}^2$) and the factor of safety is 3. Specify the size of bolts.

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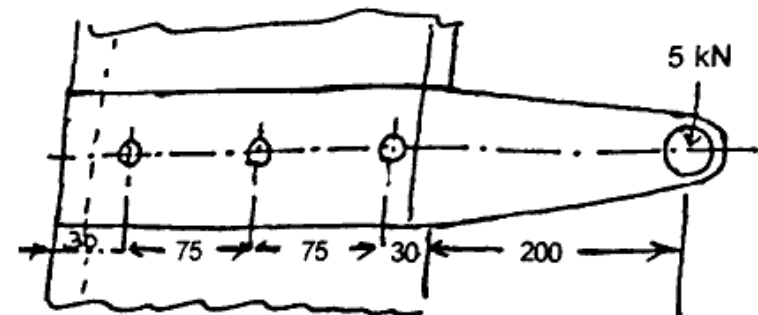


Fig. 2

- (b) A bar is raised and lowered by two 38 mm square threads, having a pitch of 7 mm. Determine the force required at a radius of 80 mm to raise or lower a 11 kN cross bar of a planar. The screw and nut materials are steel and bronze respectively. The collar material is steel; it has an outside diameter of

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(7)

76 mm and an inside diameter of 38 mm; coefficients of friction at threads and at collar are 0.11 and 0.13 respectively. 8

- (c) A vertical screw with single start square threads of 50 mm mean diameter and 12.5 mm pitch is raised against a load of 10 kN by means of a hand wheel, the boss of which is threaded to act as a nut. The axial load is taken up by a thrust collar which supports the wheel boss and has a mean diameter of 60 mm. The coefficient of friction is 0.15 for the screw and 0.18 for the collar. If the tangential force applied by each hand to the wheel is 100 N, find suitable diameter of the hand wheel. http://www.prsunotes.com 8

Q. 5. (a) Find the efficiency of following joints : 8

- (i) Single riveted lap joint of 6 mm plates with 20 mm diameter rivets having a pitch of 50 mm.

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(8)

- (ii) Double riveted lap joint of 6 mm plates with 20 mm diameter rivets having a pitch of 60 mm.

Assume :

Permissible tensile stress in plate = 100 MPa

Permissible shearing stress in plate = 80 MPa

Permissible crushing in rivets = 160 MPa

- (b) Explain different types of welding process. 8

- (c) A rectangular cross section bar is welded to a support by means of the welds as shown in Fig. 3. Determine the size of the welds, if the permissible shear stress in the weld is limited to 75 MPa. 8

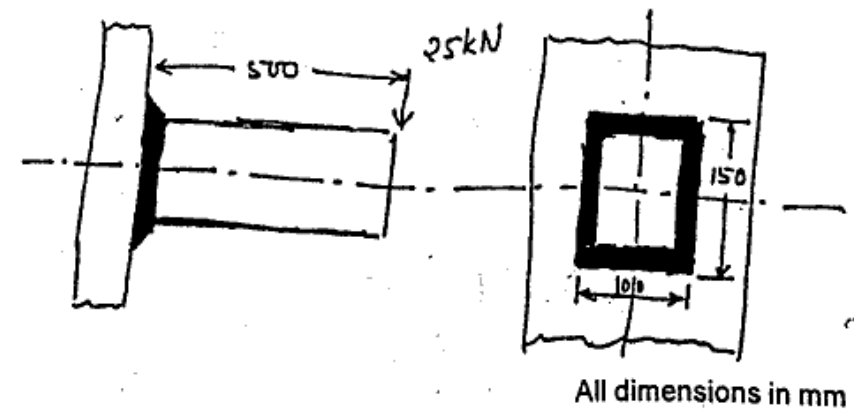


Fig. 3

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