

F-ME-551

B. E. (Fifth Semester) Examination, 2016

(New Course)

(Mechanical Engg.)

MACHINE DESIGN-I

Time Allowed : Four hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : All questions are compulsory. Each question has four parts namely (a), (b), (c) and (d). Part (a) is compulsory. Solve any two part from (b), (c) and (d). PSG databook is allowed in the examination hall. Any missing data can be assumed.

1. (a) What is Stress Concentration?

(b) Explain different types of theories of failure.

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Q.2) A cantilever beam made of cold drawn steel 20Cr ($S_u = 540 \text{ N/mm}^2$) is subjected to completely reversed load of 1000 N as shown in fig. 1. The notch sensitivity factor q at the fillet can be taken as 0.85 and the expected reliability is 90%. Determine the diameter d of the beam for a life of 10000 cycles.

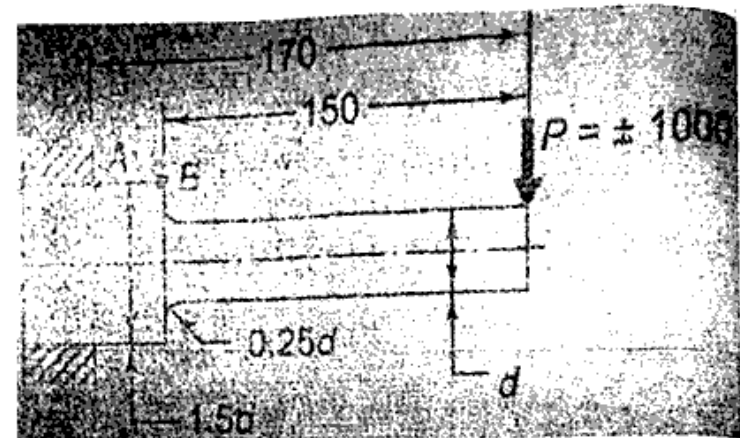


Fig. 1

(d) A solid circular shaft made of steel Fe 620 ($S_u = 620 \text{ N/mm}^2$ and $S_y = 380 \text{ N/mm}^2$) is subjected to an alternating torsional moment, that varies from -200 Nm to $+400 \text{ Nm}$. The shaft is ground and the expected reliability is 90%. Neglecting stress concentration, calculate the shaft diameter for infinite life. The factor of safety is 2. Use distortion-energy theory of failure.

(a) What do you mean by couplings? 2

(b) A flat key is used to connect a pulley to a 45 mm diameter shaft. The key is made of commercial steel ($S_{yt} = S_{yc} = 230 \text{ N/mm}^2$) and the factor of safety is 3. Determine the length of key on the basis of shear and compression consideration, if 15 kW power at 360 rpm is transmitted through the keyed joint. Assume ($S_{sy} = 0.5 S_{yt}$). http://www.prsunotes.com 7

(c) A rigid coupling is used to connect a 45 kW, 1440 rpm electric motor to a centrifugal pump. The starting torque of the motor is 225% of the rated torque. There are 8 bolts and their pitch circle diameter is 150 mm. The bolts are made of steel 45C8 ($S_{yt} = 350 \text{ N/mm}^2$) and the factor safety is 2.5. Determine the diameter of the bolts. Assume that the bolts are finger-tight in reamed and ground holes. Assume ($S_{yt} = 0.577 S_{yc}$). 7

(d) Design and draw a cotter joint to support a load varying from 30 kN in tension. The material used is carbon steel for which the following allowable stresses may be used. The load is applied statically.

Tensile stress = compressive stress = 50 MPa;

shear stress = 35 MPa and
crushing stress = 90 MPa.

3. (a) What is transmission shaft?

(b) The layout of shaft carrying two pulleys 1 and 2 and supported on two bearings A and B is shown in fig. 2. The shaft transmits 7.5 kW power at 360 rpm from pulley 1 and pulley 2. The diameters of pulley 1 and 2 are 250 and 500 mm respectively. The masses of pulley 1 and 2 are 10 and 30 kg respectively. The belt tensions act vertically downward and ratio of belt tensions on tight sides to slack side for each pulley is 2.5 : 1. The shaft is made of plain carbon steel 40C8 ($S_{yt} = 380 \text{ N/mm}^2$) and the factory of safety is 3. Estimate suitable diameter of shaft.

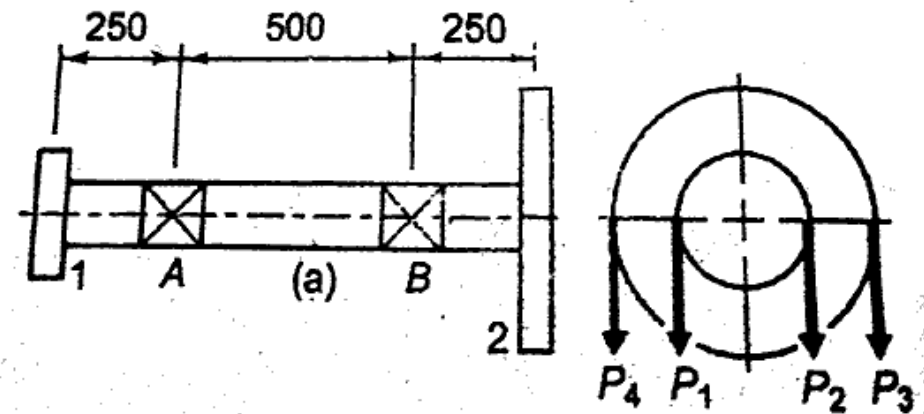


Fig. 2

(c) A multi-disk clutch consists of two steel disks with one bronze disk. The inner and outer diameters of the contacting surfaces are 200 and 250 mm respectively. The coefficient of friction is 0.1 and the maximum pressure between contacting surfaces is limited to 0.4 N/mm^2 . Assuming uniform wear theory, calculate the required operating force and the power transmitting capacity at 720 rpm.

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(d) A centrifugal clutch, transmitting 18.5 kW at 720 rpm, consists of four shoes. The clutch is to be engaged at 75% of the running speed. The inner radius of the drum is 165 mm, while the radius of the centre of gravity of each shoe, during engaged position, is 140 mm. The coefficient of friction is 0.25. Calculate the mass of each shoe.

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4. (a) What are the advantages of power screw? 2

(b) A double-threaded power screw is used to raise a load of 5 kN. The nominal diameter is 60 mm and the pitch is 9 mm. The threads are Acme type ($28^\circ = 29^\circ$) and the coefficient of friction at the screw threads is 0.15. Neglecting collar friction, calculate :

(i) the torque required to raise the load;

(ii) the torque to lower the load; and
(iii) the efficiency of the screw for lifting load.

(c) In a machine tool application, the tool holder is pulled by means of an operating nut mounted on a screw. The tool holder travels at a speed of 5 m/min. The screw has single-start square threads of 48 mm nominal diameter and 8 mm pitch. The operating nut exerts a force of 500 N to drive the tool holder. The mean radius of the friction collar is 40 mm. The coefficient of friction at thread and collar surfaces is 0.15. Calculate :

(i) power required to drive the screw; and
(ii) the efficiency of the mechanism.

(d) The structural connection shown in fig. 3 is subjected to an eccentric force P of 10 kN with an eccentricity of 500 mm from the C.G. of the bolts. The centre-distance between bolts 1 and 2 is 200 mm, and the centre-distance between bolts 1 and 3 is 150 mm. All the bolts are identical. The bolts are made from plain carbon steel 30C8 ($S_{yt} = 400 \text{ N/mm}^2$) and the factor of safety is 2.5. Determine the size of the bolts.

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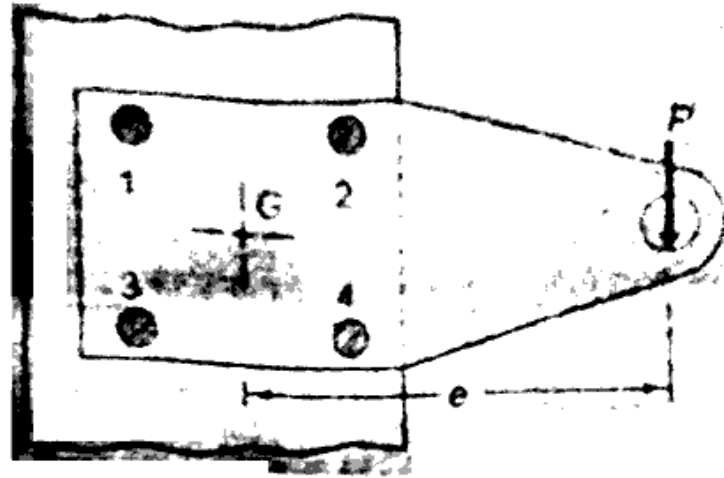


Fig. 3

(d) A double riveted lap joint is made between 15 mm thick plates. The rivet diameter and pitch are 25 mm and 75 mm respectively. If the ultimate stresses are 400 MPa in tension, 320 MPa in shear and 640 MPa in crushing, find the minimum force per pitch which will rupture the joint.

If the above joint is subjected to a load such that the factor of safety is 4, find out the actual stresses developed in the plates and the rivets.

5. ~~(a)~~ What is butt joint?

~~(b)~~ Explain different types of welding processes.

(c) A shaft of rectangular cross-section is welded support by means of fillet welds, as shown in 1

2. g Determine the size of the welds, if the permissible shear stress in the weld is limited to 75 N/mm²

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