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B. E. (Fifth Semester) Examination, Nov.-Dec. 2021

(New Scheme)

(Mech. Engg. Branch)

MACHINE DESIGN-I

Time Allowed : Four hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Part (a) is compulsory. Attempt any* ***one*** *part from (b) & (c) from each question. Support your answer with neat sketches. Assume suitable data if necessary. Use of PSG databook & Databook of Bhandari is permitted in the exam.*

1. (a) What is factor of safety? 2

(b) A rotating shaft, subjected to a non-ratating force of 5 kN & simply supported between two bearings *A*

& E as shown in Fig.1. The shaft is machined from plain carbon steel 30 C8 (S_{ut}= 540 N/mm^2) & the expected reliability is 90%. What is the life of the shaft if notch sensitivity factor is 0.78? 14

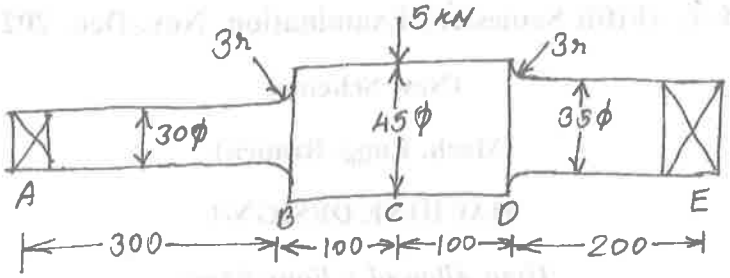

Fig. 1

(c) A cantilever beam made of cold drawn steel 40 C8 (S_{ut}= 600 N/mm^2 & S_{yt}= 380 N/mm^2) is shown is Fig. 2. The force P acting at the force end varies from –50 N to +150 N. The expected reliability is 90% & factor of safety is 2. The notch sensitivity factor at the fillet is 0·9. Find the diameter 'd' of the beam at the fillet cross-section. 14

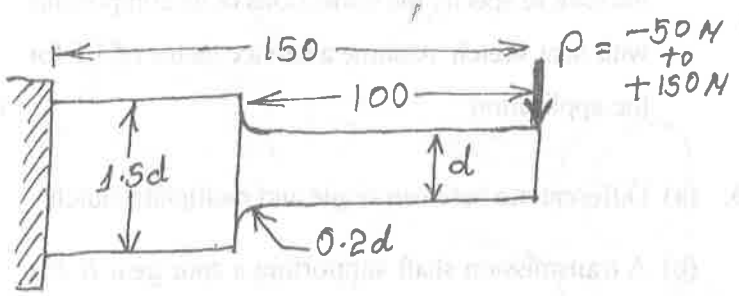

Fig. 2

2. (a) Differentiate between Saddle key and Sunk key. 2

(b) If is required to design a socket & spigot cotter joint to connect two steel rods of equal diameter. Each rod is subjected to an axial tensile force of 50 kN. The material for joint is plain carbon steel 30 C8. Assume $S_{yc} = 2\ S_{yt}$ and $S_{sy} = 0.5\ S_{yt}$. The value of FO5 for rods, socket & spigot is 6 while that for cotter is 4. Design the joint & specify the dimensions of its components with neat sketch. 14

(c) Design a rigid flange coupling transmitting 37·5 kW power at 180 rpm. The material for shaft & key is 40 C8 while that of flange is FG 200. Assume S_{yc} = 1·5 S_{yt} & S_{sy} = 0·5 S_{yt}. The value of FOS for shaft & keys is 3 while that of flange is 6. Design

the joint & specify the dimensions of its components with neat sketch. Assume a service factor of 1·5 for the application. 14

3. (a) Differentiate between single and multiplate clutch. 2

(b) A transmission shaft supporting a spur gear B & a pulley D is show in fig. 3. The shaft is mounted on two bearing A & C. The diameter of pulley & pitch circle diameter of the gear are 450 mm & 300 mm, respectively. The pulley transmits 20 kW power at 500 rpm to the gear. Both gear & pulley are keyed to the shaft. Assume

$$P_1 = 3P_2 \quad \& \quad P_r = P_t \tan 20°$$

The material for shaft is steel 50C4 (S_{ut} = 700 & S_{yt} = 460 N/mm^2). The factors K_b & K_t are 1·5 each. Find shaft diameter using ASME code. 14

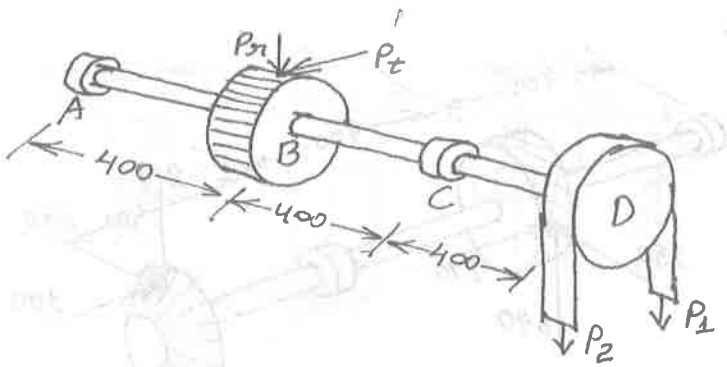

Fig. 3

(c) A transmission shaft supporting a helical gear B & a bevel gear D is shown in Fig. 4. The shaft is mounted on two bearings at A & C. The pitch circle diameter of helical gear is 450 mm & diameter of bevel gear at the forces is 450 mm. Both gears are keyed to the shaft. The material for shaft is steel 45C8 (S_{ut} = 600 & S_{yt} = 380 N/mm^2). The factors K_b is 2·0 & K_t is 4.5. Find shaft diameter using ASME code. 14

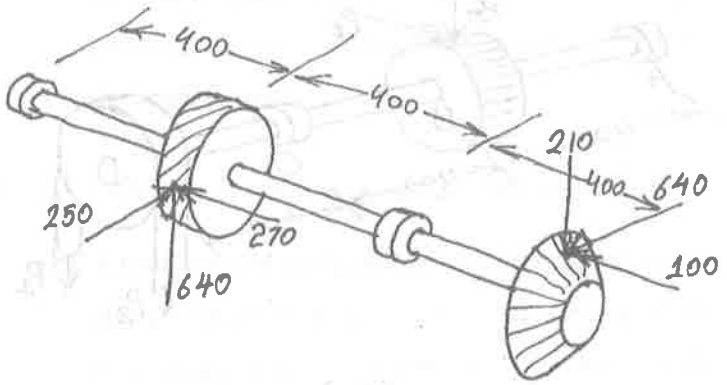

Fig. 4

4. (a) What are the basic types of threads used in power screws? 2

(b) Fig. 5 shows a bracket used in a jib crane to connect the tie rod. The maximum force in the tie rod is 5 kN which is inclined at an angle of 30° with the horizontal. The bracket is fixed by means of four identical bolts, two at *A* & two at *B*. The bolts are made of plain carbon steel 30C8 (S_{yt} = 400 N/mm^2) & FOS is 5. Assume maximum shear stress theory & find the size of the bolts. 14

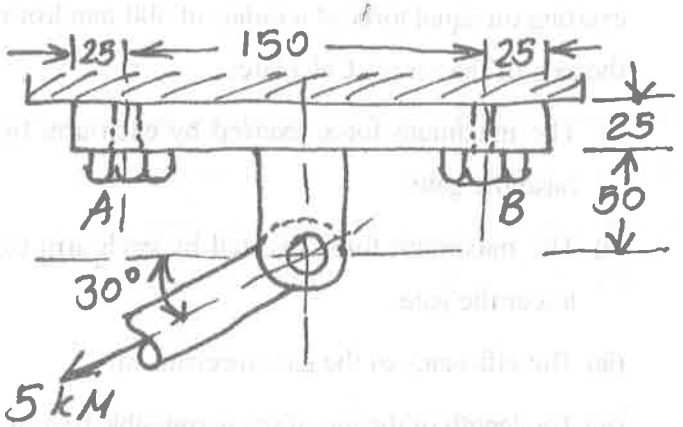

Fig. 5

(c) The screw of a gate value has single start square threads of 40 mm nominal diameter & 7 mm pitch. The weight of the gate is 5 kN. The water pressure on the gate induces a frictional resistance of 2 kN in the axial direction of screw. The screw is having a thrust washer with inner & outer diameter of 40 & 80 mm respectively. The coefficient of friction at the threads is 0·15 & at the washer is 0·12. The handle of the screw is rotated by two arms, each

exerting on equal force at a radius of 500 mm from the axis of the screw. Calculate: 14

(i) The maximum force exerted by each arm to raise the gate.

(ii) The maximum force exerted by each arm to lower the gate.

(iii) The efficiency of the gate mechanism.

(iv) The length of the nut, if the permissible bearing pressure is 5 N/mm^2.

5. (a) What are different types of joints used in riveted joints? 2

(b) A cylindrical pressure vessel with 1·5 m inside diameter is subjected to internal steam pressure of 1.5 MPa. It is made of steel plate by triple riveted double strap longitudinal butt joint with equal straps. The pitch of rivets in the outer row is twice the inner rows & the pattern is zig-zag. The efficiency should be at least 80%. Assume rivets in double shear is 1·875 times stronger than in single shear. Take permissible stresses as τ_t = 80 N/mm^2, τ = 60

N/mm^2 & τ_c = 120 N/mm^2. Design the joint with neat sketch. 14

(c) A welded connection of steel plates as shown in Fig. 6 is subjected to an eccentric force of 60 kN in the plane of welds. Find the size of welds if permissible shear stress for the weld is 100 N/mm^2. Assume static conditions. 14

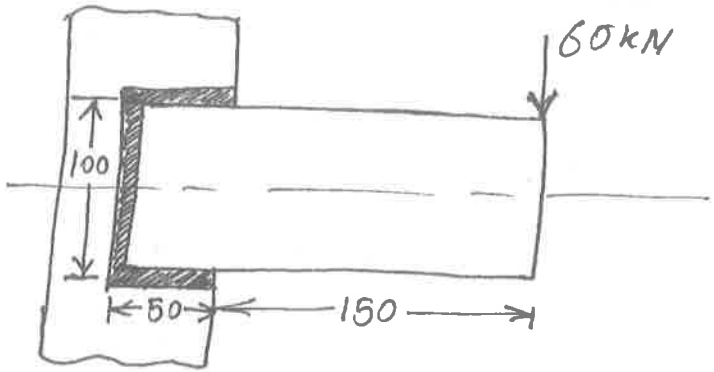

Fig. 6