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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Fifth Semester, B.E. - Mechanical Engineering

Semester End Examination; Dec - 2016/Jan - 2017

Design of Machine Elements - I

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Missing data, if any, may suitably assume.

UNIT - I

1 a. What are physical and mechanical properties? Give examples. 4

b. Briefly discuss about two important design considerations. 4

c. A circular rod made of C40 steel is simply supported between bearings 1.8 m apart. It carries a central load of 6 kN. Find suitable diameter of the rod assuming yield strength of the material as 328 MPa and factor of safety of 2.5. The deflection of the rod is not to exceed 3 mm at the centre. 12

2. Design a cotter joint to support a load varying from 30 kN in tension to 30 kN in compression. The following allowable stresses may be used for the material of the joint. Tensile stress = 50 MPa. Compressive stress = 50 MPa. Shear stress = 35 MPa. Sketch the joint and show the dimensions. 20

UNIT - II

3 a. Define maximum shear stress theory, distortion energy theory and write the respective design equations along with the design space/boundary. 8

b. Define endurance limit with the help of typical S.N. diagram. 4

c. Derive Godman design equation for fatigue load. 8

4 a. Define:

(i) Stress concentration (ii) Notch sensitivity 4

(iii) Load factor (iv) Surface finish factor.

b. The component shown in Fig 4(b) is subjected to a twisting moment that fluctuates between 2.5 kN-m and 1.5 kN-m together with a bending moment that fluctuates between +2 kN-m and -1 kN-m. Determine the dimensions of the component assuming a yield stress of 300 MPa, ultimate stress of 450 MPa, factor of safety of 2.5, Notch sensitivity factor of 0.5, size correction factor of 0.8 and surface correction factor of 0.9. 16

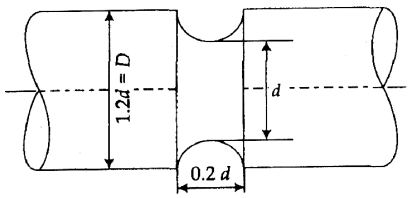

Fig.Q 4(b)

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UNIT - III

5 a. Derive the equation for impact stress due to axial load. 6

b. A solid circular shaft is subjected to a bending moment of 3000 N-m and a torque of 10000 N-m. Determine the diameter of the shaft considering SAE1045 annealed as the material of the shaft and assuming $C_M = 1.5$, $C_t = 2.0$ and factor of safety = 2.0. 14

If the shaft is replaced by a hollow shaft, where ratio of inside to outside diameter is 0.5, determine the percentage change in weight of the shaft.

6. A machine shaft running at 600 rpm is supported on bearings 750 mm apart, 15 kW of power is supplied to the shaft through a 450 mm pulley located 250 mm to the right of right bearing. The power is transmitted from the shaft through a 200 mm gear located 250 mm to the left of lift bearings the belt drive is at an angle of 60º downward from horizontal and in front of the shaft. The pulley weighs 800 N to provide some flywheel effect. The angle of contact of the belt is 180º and coefficient of friction between belt and pulley is 0.4. The gear is in mesh with another gear located directly above the shaft. If the shaft material has an ultimate strength of 500 MPa and yield stress of 310 MPa. Determine the diameter of the shaft. Pressure angle of gear drive = 20º. The shaft rotates in anticlockwise direction, when seen from left. Assume $C_M = 1.75$, $C_t = 1.25$, and FOS = 2. 20

UNIT - IV

7 a. Considering the effect of bolt Pre-tension, derive the expressions for resultant bolt load for, (i) Soft Gasket (ii) Hard Gasket. 10

b. A M20 steel bolt is used to connect two plates, each 16 mm thick. A soft copper gasket, 3 mm thick is used in between the plates for the joint to be leak proof. The outside and inside diameters of gasket are 50 mm and 22 mm respectively. Take modulus of elasticity of bolt material as 200 MPa and 120 MPa for gasket material. The bolt is subjected to an axial load of 15 kN. Determine the stress induced in the bolt. Compare the change in stress of the gasket, if not used in the joint. 10

8. A sluice gate weighing 18 kN is raised and lowered by means of square threaded screw as shown in Fig Q.8. The frictional resistance induced by water pressure against the gate is 4000 N. The outside diameter of the screw is 60 mm and pitch is 10 mm. The outside and inside diameters of washer are 150 mm and 50 mm respectively. The coefficient of friction between screw and nut is 0.1 and for the washer is 0.12. Determine; 20

(i) The maximum force to be exerted at the ends of the lever for raising and lowering the gate

(ii) Efficiency of the arrangement

(iii) Number of threads and height of the nut, if the allowable bearing pressure is 7 N/mm^2 and allowable shear stress is 40 N/mm^2.

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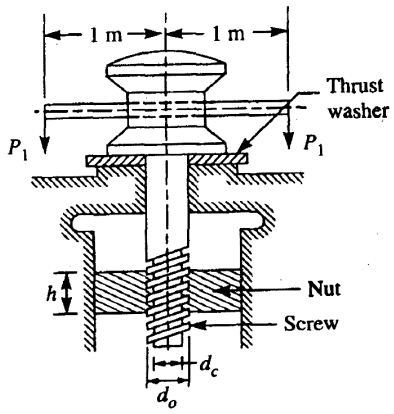

Fig.Q 8

UNIT - V

9. Design longitudinal and circumferential joints for a boiler whose inner diameter is 1.7 m and steam pressure is 2.0 MPa. Assume allowable stresses in tension, crushing and shear as 90 MPa, 150 MPa, and 60 MPa respectively. Use triple riveted double cover butt joint with unequal cover for longitudinal joint and double riveted lap joint for circumferential joint. 20

10 a. A channel welded to a steel plate as shown in Fig. 10(a) carries a tensile load of 150 kN along C.G. axis of the channel. Find suitable length of weld taking allowable tensile stress in the weld as 120 MPa. 8

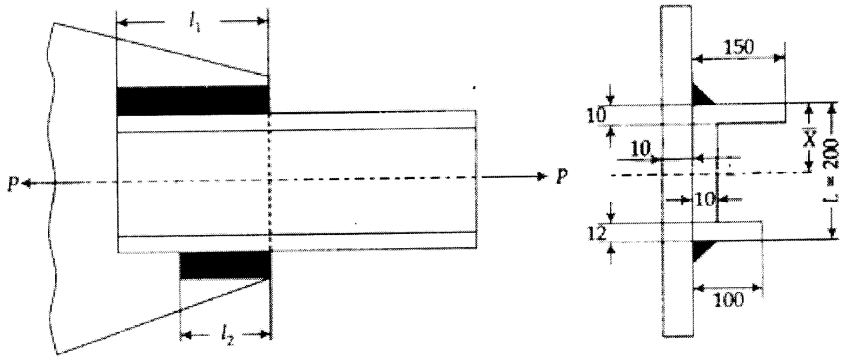

Fig.Q 10(a)

b. Determine the load carrying capacity of the welded joint shown in Fig. Q10(b), size of the weld is 12 mm and allowable shear stress in the weld is 81 MPa. 12

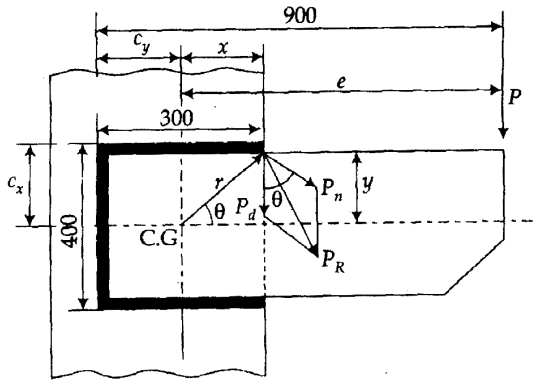

Fig.Q 10(b)

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