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06ME52

Fifth Semester B.E. Degree Examination, June/July 2016
Design of Machine Elements – I

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of machine design data handbook is permitted.***

PART – A

1 a. Explain the various theories of elastic failure of engineering materials. **(05 Marks)**

b. A rod of circular cross section is to sustain a torsional moment of 300 kNm and bending moment of 200 kNm. Selecting C45 steel (σ_{yt} = 360 MPa) and assuming factor of safety = 3, determine the diameter of rod as per the following theories of elastic failure:
i) Max. principal stress theory
ii) Max. shear stress theory
iii) Distortion energy theory **(15 Marks)**

2 a. Determine the safe load that can be carried by a bar of rectangular C/S shown in Fig.Q2(a) limiting the maximum stress to 130 MPa taking stress concentration into account.

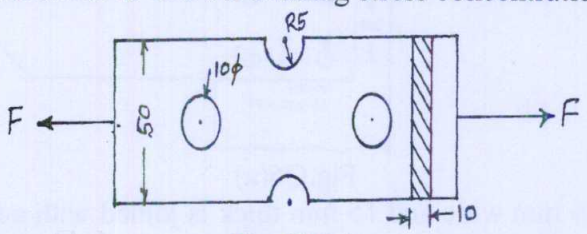

Fig.Q2(a) **(10 Marks)**

b. A machine element in the form of a cantilever beam has a rectangular C/S of 40 mm width and 120 mm depth. The span of the beam is 600 mm. A transverse load of 5000 N falls from a height of 'h' at the free end of the beam. Determine the safe value of 'h' limiting the maximum normal stress induced in the machine element due to impact to 120 MPa. The modulus of the elasticity of the material of the beam is 210 MPa. **(10 Marks)**

3 a. Derive the Soderberg equation

$$\frac{1}{N} = \frac{\sigma_m}{\sigma_y} + K_f \frac{\sigma_a}{ABC\sigma_e}$$

where A: load factor, B : size factor, C : surface finish factor. **(05 Marks)**

b. A hot rolled steel shaft is subjected to a torsional moment that varies from 330 Nm (CW) to 110 Nm (CCW) as the applied bending moment at the critical section varies from +440 Nm to –220 Nm. The shaft is of uniform cross-section and no keyway is present at the critical section. Determine the required shaft diameter. The material has an ultimate strength of 550 MPa and yield strength of 410 MPa. Take the endurance limit as half the ultimate strength, FOS = 2, size factor 0.85 and surface finish factor of 0.62. **(15 Marks)**

4 a. The cylinder head of a reciprocating air compressor is held in place by ten bolts. The total joint stiffness is four times the total bolt stiffness. Each bolt is tightened to an initial tension of 5 kN. The total external force acting to separate the joint is 20 kN. Find the size of the bolts so that the stress in the bolts is not to exceed 100 MPa. **(08 Marks)**

b. A radial drilling machine with circular base is mounted to a base plate by means of three steel bolts equally spaced on a bolt circle diameter of 0.3 m. The diameter of the circular base is 0.4 m. The spindle is positioned at a radial distance of 0.335 m from the center of the column. During drilling operation the spindle is subjected to a force of 4.5 kN. Determine the size of the bolts if the allowable stress in bolt material is limited to 100 MPa. **(12 Marks)**

PART – B

5 A solid shaft is supported on two bearings, 2 m apart and rotates at a speed of 300 rpm. Two pulleys B and D of dia 500 mm and 400 mm respectively are mounted on the shaft at distances 500 mm and 1600 mm to the right of the left bearing. A 4 mm module and 100 teeth gear is located on the shaft at 1100 mm to the left of the right bearing and drives a gear directly behind it. 20 kW is supplied to the pulley B and the machine takes 12 kW from gear C and the remaining from pulley D. The drive from B is vertically downward while the drive from pulley D is downward at an angle of 45° to the horizontal and towards the observer. In both the cases the tension ratio is 2.5. Design a suitable shaft having allowable stress 42 MPa in shear. Take $K_b = 1.75$ and $K_t = 1.25$. **(20 Marks)**

6 a. Determine the diameter of the rivet for the joint loaded as shown in Fig.Q6(a). The allowable stress in the rivets 100 MPa.

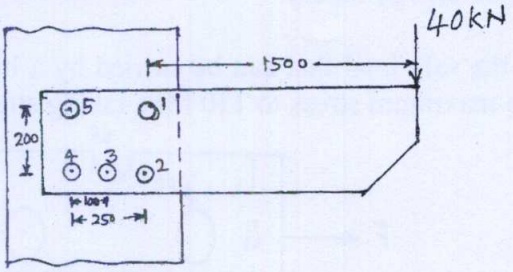

Fig.Q6(a) **(12 Marks)**

b. A plate of 120 mm wide and 15 mm thick is joined with another plate by a single transverse weld and a double parallel weld. Determine the lengths of the weld if the joint is subjected to static loading. Take $\sigma_t = 50$ MPa, $\tau = 20$ MPa. **(08 Marks)**

7 a. Design and sketch a knuckle joint to connect two mild steel rods to sustain an axial pull of 150 kN. The pin and the rods are made of the same material. Assume the working stresses in the material as 80 MPa in tension, 40 MPa in shear and 120 MPa in crushing. **(10 Marks)**

b. Design a protected type cast iron flange coupling for a steel shaft transmitting 30 KW at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted is 20% greater than the full load torque. The allowable shear stress in the bolt is 60 MPa and the allowable shear stress in the flange is 40 MPa. **(10 Marks)**

8 a. A vertical two start square threaded screw of 100 mm mean diameter and 20 mm pitch supports a load of 18 kN. The axial thrust on the screw is taken up by a collar bearing of 250 mm outside dia and 100 mm inside dia. Find the force required at the end of a lever which is 400 mm long to lift and lower the load. Coefficient of friction between nut and screw is 0.15 and for collar is 0.2. **(12 Marks)**

b. Explain self locking and over handling in power screws. State and prove the conditions for the same. **(08 Marks)**

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