CBCS SCHEME

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15ME54

Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 80

Note: **1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Any missing data may be suitably assumed.***
3. ***Use of design data hand book is permitted.***

Module-1

1 a. List the factors which govern the selection of appropriate material for a machine component. **(05 Marks)**

b. A stepped shaft with its diameter reduced for '2d' to 'd' has a fillet radius of 0.1d. Determine the diameters of the shaft and the radius of the fillet to transmit a power of 65 KW at a rated speed of 1440 rpm limiting the shear stress induced to 60 MPa. **(11 Marks)**

OR

2 a. Define stress concentration and show how stress concentration can be reduced for two examples with neat sketches. **(06 Marks)**

b. A cantilever beam of rectangular cross section with a depth of 150 mm is subjected to an axial tensile load of 40 kN and a transverse load of 50 kN acting downwards at the free end of 600 mm length beam. The material of the beam has allowable tensile stress of 100 MPa. Determine the width of rectangular section of the beam. **(10 Marks)**

Module-2

3 a. Derive an expression for impact stress induced in a member subjected to axial load. **(06 Marks)**

b. A piston rod of steam engine is subjected to a completely reversed axial load of 50 kN. The material of rod has an yield normal stress of 310 N/mm^2 and endurance stress of 289 N/mm^2. Assuming load factor of 0.7, size factor as 1 and surface finish factor as 1. Determine the diameter of rod. Choose factor of safety as 2. **(10 Marks)**

OR

4 a. Derive Soderberg's relation for a member subjected to fatigue loading. **(06 Marks)**

b. A beam of 400 mm depth I-section is resting on two supports 5m apart. It is loaded by a weight of 8 kN falling through a height of 20 mm and striking the beam at mid point. Moment of inertial of the section is 12×10^7 mm^4. Take $E = 2 \times 10^5$ N/mm^2. Determine:
i) Impact factor ii) Instantaneous maximum stress
iii) Instantaneous maximum deflection iv) Instantaneous maximum load. **(10 Marks)**

Module-3

5 A shaft mounted between bearings 1.2 m apart receives a power of 20 KW at 1000 rpm through a pulley 600 mm diameter located 400 mm from the left bearing from another pulley directly below it. The power is delivered through a pinion of 200 mm diameter located 700 mm from the left bearing to another gear in front of it. The shaft rotates clockwise when viewed through the left bearing. The belt has a ratio of tensions of 2.5 and the gears are of 20° pressure angle. The weight of the pulley is 500 N and that of the gear is 200 N. Determine the diameter of shaft. The material of the shaft has design shear stress of 60 MPa. Choose $K_b = 1.5$, $K_t = 1.0$. **(16 Marks)**

OR

6 a. Design a cotter joint to join two round rods capable of sustaining an axial load of 100 kN. The material of the joint has design tensile stress = 100 N/mm^2, crushing stress = 150 N/mm^2 and shear stress = 60 N/mm^2. **(08 Marks)**

b. A cast iron flange coupling is used to connect two shafts of 80 mm diameter. The shaft runs at 250 rpm and transmits a torque of 2500 N-m. The permissible shear stress for shaft material and bolt materials is 50 MPa and permissible shear stress for flange is 20 MPa. Design the bolts and the flange. Also select suitable key for the coupling. Take allowable normal stress for bolt as 100 MPa. **(08 Marks)**

Module-4

7 a. Design a double riveted butt joint with two cover plates for the longitudinal seam of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.95 N/mm^2. Assume an efficiency of 72%, allowable tensile stress in the plate of 90 N/mm^2, crushing stress of 140 N/mm^2 and an allowable shear stress in the rivet of 50 N/mm^2. **(08 Marks)**

b. Determine the size of weld required for an eccentrically loaded weld as shown in Fig.Q7(b). The allowable stress in the weld is 75 MPa.

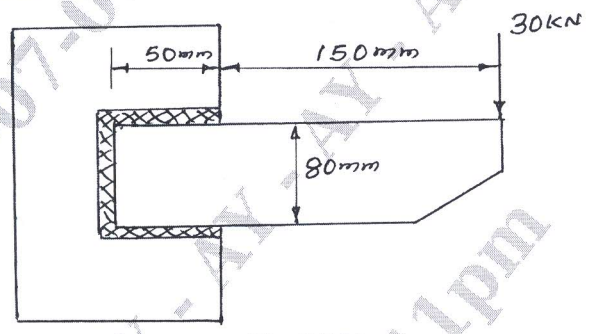

Fig.Q7(b) **(08 Marks)**

OR

8 a. Two lengths of a flat tie bar for a bridge structure of 250 mm wide and 18 mm thick are connected by a diamond joint with equal cover plates on either side. Design the joint completely working stresses for the material of the bar are 100 MPa in tension, 70 MPa in shear and 160 MPa in crushing. **(08 Marks)**

b. One end of a rectangular bar of cross section 120 mm × 70 mm is welded to a vertical support by four fillet welds along its circumference. A steady transverse load of 10 kN is applied at the free end of the bar of length 160 mm and is parallel to 120 mm side. Determine the size of weld, if the allowable stress in the material is limited to 115 MPa. **(08 Marks)**

Module-5

9 a. A bracket is fixed to the wall by means of four bolts and loaded as shown in Fig.Q9(a). Calculate the size of bolts if the load is 10 kN and allowable shear stress in the bolt material is 40 MPa.

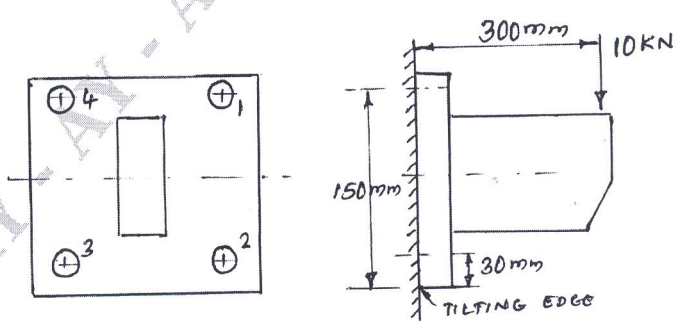

Fig.Q9(a) **(08 Marks)**

b. A square threaded power screw has a nominal diameter of 30 mm and a pitch of 6 mm with double threads. The load on the screw is 6 kN and the mean diameter of the thrust collar is 40 mm. the coefficient of friction for the screw is 0.1 and the collar is 0.09. Determine:
   i) Torque required to raise and lower the screw with load
   ii) Overall efficiency **(08 Marks)**

OR

10 A screw jack is to lift a load of 80 kN through a height of 400 mm ultimate strength of screw material in tension and compression is 200 N/mm^2 and in shear 120 N/mm^2. The material for the nut is phosphor bronze for which the ultimate strength is 100 N/mm^2 in tension and 90 N/mm^2 in compression and 80 N/mm^2 in shear. The bearing pressure between the nut and the screw is not to exceed 18 N/mm^2. Design the screw and nut and check for stresses. Take FOS = 2, $\mu = 0.14$. Design jack for 25% overload. **(16 Marks)**

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