CBCS SCHEME

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15MT51

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

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of Design data handbook is permitted.

Module-1

1 a. A bolt is subjected to a normal load of 18 kN and a shear load of 12 kN. The material has yield stress of 328.6 MPa. Determine the diameter of bolt according to Rankine's theory, max shear stress theory and Von Mises theory. Take Factor of safety = 2.5. **(10 Marks)**

b. State and explain Von Mises theory and normal stress theory. **(06 Marks)**

OR

2 a. A stepped shaft of circular cross section is made up of 20 Mn_2(σ_y = 431.5 MPa). Determine the value of 'd' and the fillet radius so that maximum stress is limited to a ratio corresponding to FOS of 2.5 [Refer Fig.Q2(a)]. **(08 Marks)**

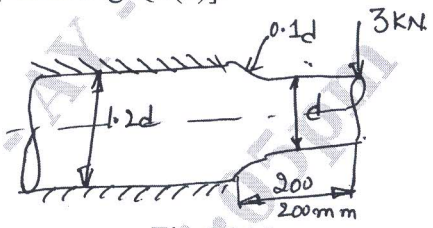

Fig.Q2(a)

b. State and explain Design considerations. **(08 Marks)**

Module-2

3 a. Design a Cotter Joint to carry a maximum load of 100 kN. The material used for spigot end, socket end and other parts is C40 steel. Take FOS = 4 for tension, FOS = 3 for crushing and FOS = 6 for shear based on yield strength of material. **(08 Marks)**

b. It is required to design rigid type flange coupling to connect two shafts. Input shaft transmits 37.5 kW at 180 RPM to the shaft through coupling. The starting torque is 50% greater than the rated torque. Select the material for flange as Cast Iron FG 200 with ultimate stress = 200 MPa and FOS = 6. Material for shaft as steel with yield stress = 380 MPa and FOS = 2.5. Material for the bolt and key may be taken as steel with yield stress in tension as 400 MPa and in compression as 600 MPa with FOS = 2.5. **(08 Marks)**

OR

4 a. Derive an expression for torque required to lift the load on square threaded screw. **(06 Marks)**

b. A triple threaded power screw is used in a screw jack has a nominal diameter of 50 mm and a pitch of 8 mm. The threads are square shape and the length of nut is 48 mm. The screw jack is used to lift a load of 7.5 kN. The coefficient of friction at thread is 0.12 and collar friction is negligible. Calculate
(i) Principle shear stress in the screw thread
(ii) Unit bearing pressure for threads
(iii) State whether screw is self locking or not. **(10 Marks)**

Module-3

5 A shaft is supported between 2 bearings placed 1 mtr apart. A 600mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt of maximum tension 2.25 kN. Another pulley of 400 mm diameter is placed 200 mm to the left of right hand bearing and is driven by motor and belt which is placed horizontal to the right. Angle of contact for both pulley is 180° and coefficient of friction is 0.24. Determine suitable diameter of the solid shaft allowing working stress of 63 MPa in tension and 42 MPa is shear. **(16 Marks)**

OR

6 A solid steel shaft transmitting 15 kW at 200 RPM is supported on 2 bearings 750 mm apart and two gears keyed to it. The pinion having 30 teeth of 5 mm module is located 100 mm to the left of right hand bearing and delivers power horizontal to the right. The gear having 100 teeth of 5 mm module is located 150 mm to the right of the left hand bearing and receives power in vertical direction from below using allowable stress of 55 MPa in shear. Determine the diameter of the shaft. **(16 Marks)**

Module-4

7 A pair of spur gear to transmit 12 kW at 1200 rpm of pinion has a velocity ratio of 4:1, pitch line velocity of the gear is limited to 12 m/s. Take allowable static stress σ_d = 138 MPa for both gears and pressure angle as 20° FDI. Also assume face width as 10 times the module and service factor as 1.5. Check the gear for wear. **(16 Marks)**

OR

8 A pair of helical gears is to transmit at 15 kW at 5000 RPM of the pinion. Both gears are made up of steel with allowable bending stress of 120 MPa. The gear has to operate at centre distance of 200 mm and speed reduction of 4:1. Teeth are 20° FDI and helix angle is 45°. Gears are manufactured to class III accuracy, face width can be assumed as $16m_n$. Determine module, face width, number of teeth and suggest suitable hardness. **(16 Marks)**

Module-5

9 a. Design a helical spring to sustain a load that fluctuates from 1000N – 1800N with an associated deflection of 25mm during the course of change in load. The mean diameter of spring may be taken as 8 times the spring wire diameter. The material selected has following properties.

τ_y = 900 MPa , $\tau_{endurance}$ = 800 MPa , G = 80.9 GPa , Factor of safety = 2.25. **(08 Marks)**

b. A railway wagon weighing 50 kN moving with speed of 8 km/hr has to be stopped by 4 buffer spring in which maximum compression allowed is 220 mm. Find the active number of turns in each spring of mean diameter 150 mm. Diameter of spring wire is 25mm. Also determine maximum shear stress in each spring. Take G = 84 GPa. **(08 Marks)**

OR

10 a. Derive Petroff's equation with suitable assumptions. **(06 Marks)**

b. Design a Journal bearing for a centrifugal pump for the following data: W = 20000 N, N = 900 RPM, Type of oil is SAE-10 for which absolute viscosity at 55°C is 0.017 kg/ms, Ambient temperature of the oil is 15.5°C, Maximum bearing pressure is 1.5 N/mm^2. Calculate the mass of lubricant oil required for artificial cooling if temperature rise of oil is 10°C and heat dissipation coefficient as 1232 W/m^2 °C. **(10 Marks)**

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