CBCS SCHEME

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15MT51

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022
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 data handbook is permitted.

Module-1

1 a. Explain briefly the six steps involves in the design procedure. **(05 Marks)**

b. What are the mechanical properties of metals? Explain any four properties. **(05 Marks)**

c. A 50 mm diameter steel rod supports a 9 kN load and in addition to subjected to a torsional moments of 100 N-m as shown in Fig.Q.1(c). Determine the maximum tensile and the maximum shear stress.

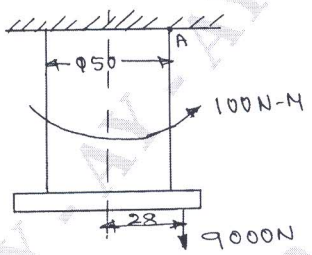

Fig.Q.1(c) **(06 Marks)**

OR

2 a. Explain the following theories of failure:
i) Max principal stress theory ii) Max shear stress theory **(04 Marks)**

b. A rod of circular section is to sustain a torsional moment of 300 kN-m and bending moment 200 kN-m. Selecting C-45 steel (σ_{yt} = 353 MPa) and assuming F.D.S = 3, determine the diameter of rod per following theories of failure:
i) Maximum shear stress theory ii) Distortion energy theory
iii) Total energy theory iv) Maximum normal stress theory **(12 Marks)**

Module-2

3 a. A rectangular sunk key 14 mm wide × 10 mm thick × 75 mm long is required to transmit 1200 N-m torque from a 50 mm diameter solid shaft. Determine whether the length is sufficient or not of the permissible shear stress and crushing stress are limited to 56 MPa and 168 MPa respectively. **(06 Marks)**

b. Design the knuckle joint to connect two mild steel rods subjected to an axial load of 100 kN. The allowable stresses for rods and pins are 100 MPa, 130 MPa and 60 MPa in tension, crushing and shear respectively. **(10 Marks)**

OR

4 a. Explain the self locking and overhauling in power screws. **(06 Marks)**

b. The lead screw of a lathe has single start ISO metric trapezoidal threads of 52 mm nominal diameter and 8 mm pitch. The screw is required to exert an axial force of 2 kN in order to drive. The tool carriage during turning operation. The thrust is carried on a collar of 100 mm outer diameter and 60 mm inner diameter. The values of C.O.F at the screw threads and collar area 0.15 and 0.12 respectively. The lead screw rotates at 30 rev/min. Calculate:
(i) Power required to drive the screw (ii) Efficiency of the screw. **(10 Marks)**

Module-3

5 A horizontal commercial shaft is supported by two bearings 1.5 m apart. A keyed gear, 20° involute and 175 mm in dia is located 400 mm to the left of the right hand bearing and is driven by a gear directly behind it. A 600 mm dia pulley is keyed to the shaft 600 mm to the right of the left hand bearing and drives a pulley with a horizontal belt directly behind it. The tension ratio of the belt is 3 to 1 with a slack side on top. The drive transmits 45 KW at 330 rpm. Take $C_m = C_t = 1.5$ calculate the necessary diameter of the shaft. Use allowable shear stress 40 MPa and G = 80 GPa. **(16 Marks)**

OR

6 a. A line shaft at 500 rpm is to transmit 600 KW. The allowable shear stress for the material of the shaft is 42 MPa. If the shaft carries a central load of 900 N and is simply supported between the bearings 3 m apart, determine the dia of the shaft. The maximum tensile stress is not to exceed 50 MPa. **(08 Marks)**

b. A shaft is required to transmit 1 MW at 240 rpm. The shaft must not twist more than 1° on a length of 15 dia. If G = 80 GPa, find the dia of the shaft and shear stress induced. **(08 Marks)**

Module-4

7 A pair of spur gear to transmit 12kW at 1200rpm of pinion has a velocity ratio of 4:1, putch line velocity of the gear is limited to 12m/s. Take allowable static stress σ_d = 138MPa 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 Design a helical gear for following specification, power transmitted 40 KW, speed 1400 rpm. Determine module. **(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 = 900MPa, $\tau_{endurance}$ = 800MPa, G = 80.9GPa, Factor of safety = 2.25. **(08 Marks)**

b. A railway wagon weighing 50kN moving with speed of 8km/hr has to be stopped by 4 buffer spring in which maximum compression allowed is 220mm. Find the active number of turns in each spring of mean diameter 150mm. Diameter of spring wire is 25mm. Also determine maximum shear stress in each spring. Take G = 84GPa. **(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 = 20000N, N = 900RPM. Type of oil is SAE-10 for which absolute viscosity at 55°C is 0.017kg/ms, Ambient temperature of the oil is 15.5°C, Maximum bearing pressure is 1.5N/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 1232W/m^2°C. **(10 Marks)**

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