CBCS SCHEME

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18MA54

Fifth Semester B.E Degree Examination, Feb./Mar.2022
Elements of Machine Design

Time: 3 hrs. Max. Marks: 100

Note: **1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Design data Hand Books are allowed.***

Module-1

1 a. A member is subjected to pure shear such that the shear stress in a member is 50 MPa. Determine the factor of safety (FOS) by,
(i) Maximum shear stress theory. (ii) Distortion energy theory.
If the yield stress in tension is 300 N/mm^2 **(08 Marks)**

b. A circular rod of diameter ϕ50 is subjected to loads as shown in Fig. Q1 (b). Determine the nature and magnitude of stresses at the points A and B.

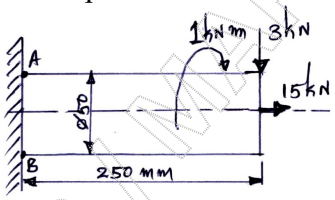

Fig. Q1 (b) **(12 Marks)**

OR

2 a. A bar of rectangular section is subjected to an axial pull of 500 kN, as in Fig. Q2 (a). Determine its thickness. If allowable tensile stress in the bar is 200 MPa. **(10 Marks)**

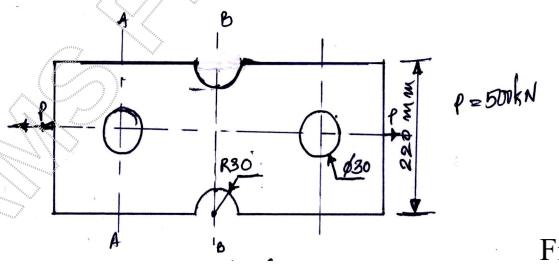

Fig. Q2 (a)

b. A steel rod is 1.5 m long. It has to resist longitudinally an impact 2.5 kN falling under gravity at a velocity of 0.99 m/s. Design the diameter of the rod, if maximum allowable stress limited to 150 MPa. E = 206.8 GPa **(10 Marks)**

Module-2

3 a. A piston rod is subjected to a maximum reversed axial load of 110 kN. It is made of steel having an ultimate stress of 900 N/mm^2 and the surface is rough. The average endurance limit is 50% of the ultimate strength. Take the size correction factor as 0.85 and factor of safety 1.75. Determine the diameter of the rod. **(10 Marks)**

b. Determine the maximum load for the simply supported beam cyclically loaded as shown in Fig. Q3 (b). The ultimate strength is 700 MPa, the yield stress in tension is 520 MPa and the endurance limit in reversed bending is 320 MPa. Use a factor of safety of 1.25. The load size and surface correction factors are 1.0, 0.75 and 0.9 respectively.

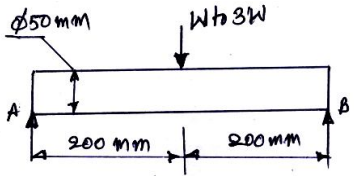

Fig. Q3 (b) **(10 Marks)**

OR

4 A solid shaft running at 600 rpm is supported on bearings 600 mm apart. The shaft receives 40 kW through a 400 mm diameter pulley weighing 400 N located 300 mm to the right of left bearing by a vertical flat belt drive. The power is transmitted from the shaft through another pulley of diameter 600 mm weighing 600 N located 200 mm to the right of right bearing. The belt drives are at right angles to each other and ratio of belt tension is 3. Determine the size of the shaft. If the allowable shear stress is 40 MPa and loads are steady. **(20 Marks)**

Module-3

5 A pair of carefully cut spur gears with 20˚ full depth involute profile is used to transmit 12 kW at 1200 rpm of pinion. The gear has to rotate at 300 rpm. The material used for both pinion and gear is medium carbon steel having allowable bending stress is 230 MPa. Determine the module and face width of the spur pinion and gear. Suggest suitable hardness. Take 24 teeth on pinion, E = 210 GPa. **(20 Marks)**

OR

6 Design a pair of bevel gears to connect two shafts at 60˚. The gears are alloy steel of case hardened and precision cut with form cutters. The gear ratio is 5 : 1. The power transmitted is 30 kW at 900 rpm of the pinion. The teeths are 20˚ full depth. The pinion has 24 teeth. Suggest suitable surface hardness for the gear pair. **(20 Marks)**

Module-4

7 a. A square key is required to transmit a torque of 400 Nm from a shaft 40 mm diameter. If the length of the hub is 70 mm. Determine the dimensions of the side of the square key. If key and shaft having allowable shear stress of 60 N/mm^2. **(06 Marks)**

b. Design a rigid flange coupling to transmit 10 kW at 100 rpm. Assume shaft, bolts and flange material yield stress as $\sigma_y = 328.6$ MPa, $\tau_y = 164.3$ MPa and FOS = 3. **(14 Marks)**

OR

8 Design a pin type flexible coupling to transmit 10 kW at 500 rpm. Assume C40 steel for shaft, bolts and key material, $\sigma_y = 328.6$ MPa, FOS = 2. **(20 Marks)**

Module-5

9 a. What are the requirements of good lubricant? **(06 Marks)**

b. Explain the following : (i) Dynamic viscosity (ii) Kinematic viscosity **(04 Marks)**

c. A lightly loaded journal bearing has a load of 1 kN. The oil used is SAE60 and mean effective temperature of operation is 40˚C. The journal has a diameter of 50 mm and the bearing has a diameter of 50.5 mm. The speed of journal is 15000 rpm. The L/d ratio is limited to 1.2. Determine the coefficient of friction and power loss due to friction $\eta = 210$ CP. **(10 Marks)**

OR

10 a. Explain with neat sketches, the working principle of, (i) Journal bearing (ii) Thrust bearing. **(06 Marks)**

b. Explain : (i) Bearing modulus (ii) Attitude **(04 Marks)**

c. Determine the main dimensions and power loss of a multicollar thrust bearing for a propeller shaft of 450 kW marine oil engine. One engine makes 250 rpm. The shaft diameter is 150 mm and the speed of the ship is 5 m/s. **(10 Marks)**

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