CBCS SCHEME

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15MT51

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Design of Machine Elements

Time: 3 hrs. Max. Marks: 80

Note: ***Answer FIVE full questions, choosing one full question from each module.***

Module-1

1 a. Define machine design and explain the basic design procedure. **(08 Marks)**

b. Define standardization. State the standards used in machine design. **(04 Marks)**

c. Mention the stress tensor and the relationship between normal stress and normal strain for a three dimensional (Tri-axial) stress field. **(04 Marks)**

OR

2 a. Explain maximum normal stress theory and maximum shear stress theory of failure. **(10 Marks)**

b. Find the value of the maximum stress induced on the fillet if the stress concentration factor for the filleted flat box having a D/d ratio of 1.2. Also determine the factor of safety if the flat box is made of steel having a yield stress of 640 N/mm^2. Thickness of the box is 25 mm. **(06 Marks)**

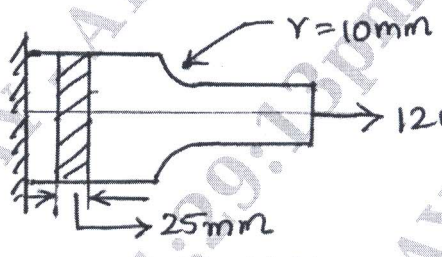

Fig. Q2 (b)

Module-2

3 a. Design a Spigot type cotter joint to sustain an axial load of 100 kN. The material selected for the joint has the following design stresses:
$\sigma_t = 100$ N/mm^2, $\sigma_c = 150$ N/mm^2 and $\tau = 60$ N/mm^2 **(06 Marks)**

b. Determine the dimensions of a tapered key to transmit 10 kW at 1000 rpm. Also find the axial force necessary to drive the key home. The permissible shear and compressive stresses in the key material are 60 N/mm^2 and 130 N/mm^2 respectively. **(10 Marks)**

OR

4 a. Explain self locking and overhauling in power screws. **(04 Marks)**

b. 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 is 120 N/mm^2. The material for the nut is phosphor bronze for which the ultimate strength is 100 N/mm^2 intension 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. **(12 Marks)**

Module-3

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

OR

6 A hollow C15 steel ($\sigma_y = 235.4$ MPa, $\sigma_u = 425$ MPa) shaft transmits 15 kW at 250 rpm. It is supported on two bearings 750 mm apart. A 500 mm pulley whose weight is 1000 N is keyed to the shaft at a distance of 100 mm to the left of left bearing. A pinion having 75 teeth and 4 mm module is mounted at 150 mm to the left of right bearing. The pulley is driven by a belt down ward at an angle of 60° to the horizontal and towards left. The pinion drives a gear placed directly over it Tension ratio = 3 and diameter ratio = 2. Determine the diameter of the shaft. Assume the shaft rotates clockwise when viewed from right bearings. **(16 Marks)**

Module-4

7 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. Whose allowable bending stress may be taken as 230 MPa. Determine the module and face width of the spur gear and pinion. Suggest suitable hardness. Take 24 teeth on pinion. Modulus of Elasticity = 210 GPa. **(16 Marks)**

OR

8 Design a pair of helical gear to transmit 12 kW at 2400 rpm of pinion. The velocity ratio required is 4 : 1. Helix angle is 23°. The centre distance is to be around 300 mm. Pressure angle in the normal plane is $14\frac{1}{2}^\circ$ involute. Pinion material is cast steel ASTM class B. Gear material is cast iron better grade. Suggest suitable hardness. **(16 Marks)**

Module-5

9 a. Derive Petroff's equation, with assumptions. **(06 Marks)**

b. Design a full journal bearing subjected to 6000 N at 1000 rpm of the journal. The journal is of hardened steel and the bearing is of babbit metal. The bearing is operating with SAE40 oil at 70°C and the ambient temperature is 30°C. Also determine the amount of artificial cooling required. **(10 Marks)**

OR

10 a. Derive the stresses in helical springs of circular wire subjected to compression load. **(06 Marks)**

b. The valve spring of a Gasoline engine is 40 mm long when the valve is open and 48 mm long when the valve is closed. The spring loads are 250 N when the valve is closed and 400 N when the valve is open. The inside diameter of spring is not to be less than 25 mm and factor of safety is 2. Design the spring. **(10 Marks)**

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