CBCS SCHEME

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15ME54

Fifth Semester B.E. Degree Examination, July/August 2021
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 80

Note: **1.** ***Answer any FIVE full questions.***
2. ***Use of design data hand book is permitted.***
3. ***Assume missing data, if any, suitably.***

1 a. Define Mechanical Engineering design. Explain phases of design with a neat block diagram. **(06 Marks)**

b. A hollow shaft of 40 mm outer diameter and 25 mm inner diameter is subjected to a twisting moment of 118 N-m, axial tensile load of 10 kN and a bending moment of 80 N-m. Calculate the maximum tensile and maximum shear stress. **(10 Marks)**

2 a. A grooved shaft shown in Fig.Q2(a) transmits 10 KW at 1000 rpm. Determine the diameter of the shaft at the groove. The permissible stress for the shaft material can be taken as 150 MPa.

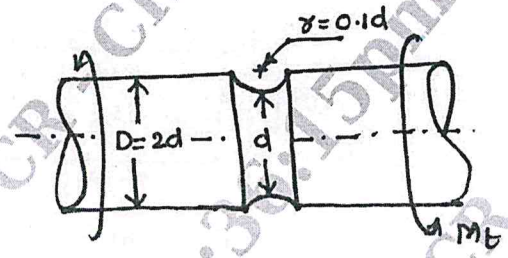

Fig.Q2(a) **(08 Marks)**

b. A link made of grey cast iron having a permissible stress of 100 MPa is subjected to a force of 25 kN as shown in Fig.Q2(b). Determine the dimensions of the cross-section of the link.

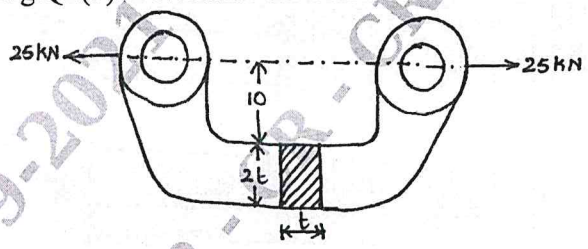

Fig.Q2(b) **(08 Marks)**

3 a. Derive an expression for impact stress in a axial bar of cross-section 'A' and length 'L' due to impact of a load 'W' falling from a height 'h'. **(08 Marks)**

b. A mass of 50 kg drops through 25 mm at the center of a 250 mm long simply supported beam. The beam has square cross-section having an allowable stress of 200 MPa. Determine the dimensions of the cross-section of the beam. Take E = 207 GPa. **(08 Marks)**

4 A round rod of diameter 1.2 d is reduced to a diameter 'd' with a fillet radius of 0.1d. The stepped rod is to sustain a twisting moment that fluctuates between +2.5 kN-m and +1.5 kN-m together with a bending moment that fluctuates between +1 kN-m and −1 kN-m. The rod is made of carbon steel C40 (σ_y = 328.6 MPa; σ_u = 620 MPa). Determine a suitable value for 'd'. **(16 Marks)**

5 A commercial steel shaft transmits 15 kW at 300 rpm. It is supported on two bearings 1.2 m apart. The shaft receives power through a 450 mm diameter pulley mounted at 300 mm to the right of right bearing. The power is given out through a 300 mm diameter gear mounted at 250 mm to the right of left bearing. The belt drive is horizontal and gear drive with a downward tangential force. Design the shaft. Allowable stress for the shaft with keyway is 40 MPa. Take $K_b = K_t = 1.5$ and ratio of belt tension = 3. **(16 Marks)**

6 Design a cast iron flange coupling to connect two shafts of 45 mm diameter to transmit 20 KW power at 400 rpm. The permissible shear strength for the shaft, bolt and the key is 50 MPa and the permissible compressive stress is 120 MPa. The permissible shear stress for cast iron is 15 MPa. Assume starting torque is 30 percent higher than the normal torque. Take keyway factor as 0.75. **(16 Marks)**

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 75%, allowable tensile stress in the plate is 90 N/mm^2, allowable crushing stress of 140 N/mm^2 and an allowable shear stress in the rivet as 56 N/mm^2. **(08 Marks)**

b. Determine the load carrying capacity for the riveted joint shown in Fig.Q7(b). The allowable stress in the 20 mm diameter rivet is 100 N/mm^2.

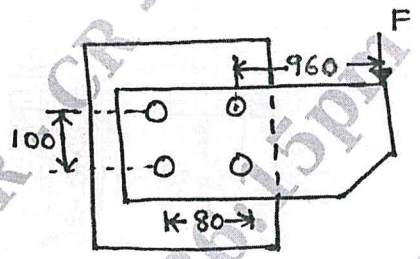

Fig.Q7(b) **(08 Marks)**

8 a. A welded joint shown in Fig.Q8(a) is subjected to an eccentric load of 2.5 kN. Find the size of the weld if maximum stress in the weld is 25 MPa.

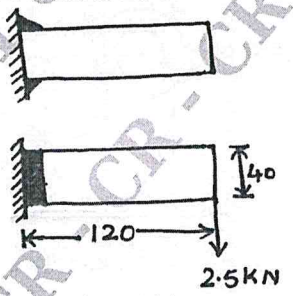

Fig.Q8(a) **(08 Marks)**

b. Find the size of the weld for a bracket loaded as shown in the Fig.Q8(b). The allowable stress for the weld may be taken as 75 MPa.

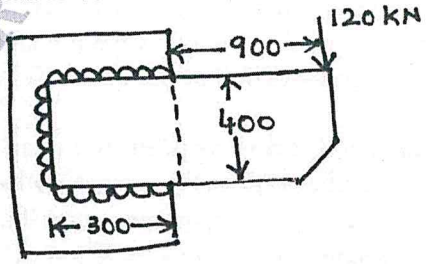

Fig.Q8(b) All dimensions are in mm **(08 Marks)**

9 a. A M10 steel bolt of 125 mm long is subjected to an impact load. The kinetic energy absorbed by the bolt is 2.5 J. Determine:
(i) Stress in the shank of the bolt if there is no threaded portion between the nut and the bolt head.
(ii) Stress in the shank if the area of the shank is reduced to that of the root area of the thread or the entire length of the bolt is threaded.
Take E = 206 GPa. **(08 Marks)**

b. A steel bracket subjected to a force of 10 kN and fixed to a channel is as shown in Fig.Q9(b). Determine the size of the bolt if the allowable shear stress in the material is 70 N/mm^2.

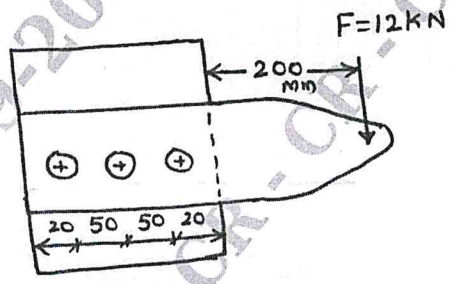

Fig.Q9(b) **(08 Marks)**

10 a. A split nut used with a lead screw is propelled at a speed of 5 m/min, against a load of 20 kN, along the spindle of a square thread (single start) having nominal diameter of 30 mm and pitch of 6 mm. The axial thrust is absorbed by a collar of 100 mm outside diameter and 70 mm inside diameter. Assuming suitable coefficient of friction, determine:
(i) Power required to drive
(ii) Height of bronze nut required if allowable bearing pressure is 17 MPa
(iii) Efficiency of the drive. **(08 Marks)**

b. A Sluice gate weighing 600 kN is raised and lowered by two 75 mm square threaded screw. The screws are operated by a 600 rpm motor. The coefficient of collar friction is 0.03 and coefficient of thread friction is 0.14. The outer diameter of the collar is 100 mm and inner diameter is 50 mm. The gate is to be raised at a rate of 0.6 m/min. Determine the power required to raise the gate. **(08 Marks)**

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