CBCS SCHEME

USN | | | | | | | | | | 17ME54

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

Time: 3 hrs. Max. Marks: 100

Note:1. ***Answer FIVE full questions, choosing one full question from each module.***
2. ***Use of design data hand book permitted.***

Module-1

1 a. With flow diagram, explain the phases of design. **(05 Marks)**

b. List and explain the factors to be considered for selection of material for a machine component. **(05 Marks)**

c. A point in a structural member is subjected to plane stress as shown in Fig. Q1 (c). Determine the following :
(i) Normal and tangential stress on a plane inclined at 45°.
(ii) Principal stresses and directions.
(iii) Maximum shear stress. **(10 Marks)**

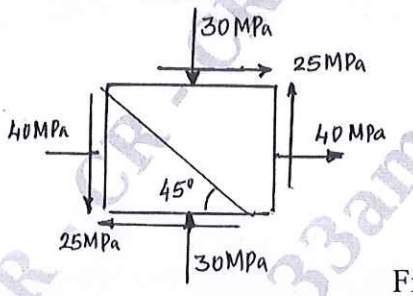

Fig. Q1 (c)

OR

2 a. What is stress concentration? Explain with neat sketches any three methods to reduce stress concentration in machine elements. **(05 Marks)**

b. A round shaft made of Grey Cast Iron FG200 with $\sigma_{ut} = 200$ MPa, is subjected to a bending moment of 15 N.m is as shown in Fig. Q2 (b). The theoretical stress concentration factor at fillet is 1.5. Determine the diameter 'd' and max stress at the fillet. **(05 Marks)**

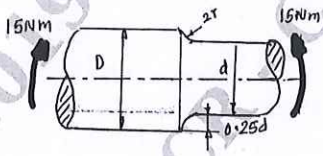

Fig. Q2 (b)

c. A 50 mm steel rod supports a 9 kN load in addition to this a torsional moment of 100 N.m is applied on it as shown in Fig. Q2 (c). Determine the maximum tensile and maximum shear stresses. **(10 Marks)**

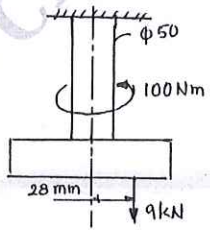

Fig. Q2 (c)

Module-2

3 a. Explain with sketches, the different types of varying stresses. **(05 Marks)**

b. Derive Soderberg equation for designing members subjected to fatigue loading. **(05 Marks)**

c. A steel cantilever beam is 200 mm long. It is subjected to an axial load varies from 150 N (compression) to 450 N (tension) and a transverse load at its free and which varies from 80 N (up) to 120 N (down). The Cantilever beam is of circular cross section having a diameter of 2 d for the first 50 mm and diameter 'd' for the remaining length. Determine its diameter using the following data. Use Soderberg equation.
Factor of safety = 2 ; Yield stress = 330 MPa; Endurance limit = 300 MPa
Stress concentration factor = 1.44 for bending,
1.64 for axial loading,
load correction factor = 0.7 for axial loading
1 for bending
Size correction factor = 0.85; Notch sensitivity = 0.9
Surface correction factor = 0.9 **(10 Marks)**

OR

4 a. Derive an expression for impact stress induced in a member subjected to axial load. **(05 Marks)**

b. Design a rod of solid circular cross section of length 200 mm (placed vertical) to sustain an axial compressive load of 1000 N, that falls on it from a height of 10 mm. The material selected has a design stress of 80 N/mm^2 and Young's modulus = 2.1×10^5 N/mm^2. **(05 Marks)**

c. A mass of 500 kg is being lowered by means of a steel wire rope having cross sectional area 250 mm^2. The velocity of the weight is 0.5 m/s, when the length of the extended rope is 20 m, the sheave gets stuck up. Determine the stress induced in the rope due to sudden stoppage of the sheave. Neglect friction. Take E = 190 GPa. **(10 Marks)**

Module-3

5 A commercial steel shaft with allowable shear stress 40 MPa. With shock factors for bending and twisting is 1.5 and 1 respectively. The length of the shaft between bearings is 600 mm, carries a pulley of 400 mm dia meter having weight 400 N, mounted in middle of the shaft. Shaft receives 40 kW at 600 rpm by a flat belt drive. Power from motor shaft is transmitted through another pulley of diameter 600 mm weighing 600 N overhanging the right hand bearing by 200 mm. The belt drives on pulleys are right angles to each other. Take ratios of belt tensions as 3, determine the diameter of the shaft. Use ASME code for shaft design. **(20 Marks)**

OR

6 a. Design a protected type CI flange coupling for a steel shaft transmitting 30 kW at 200 rpm. The allowable shear stress in the shaft and key materials 40 MPa. The maximum torque transmitted is 20% greater than full load torque. The allowable shear stress in the bolt is 60 MPa and allowable shear stress in the flange is 40 MPa. **(10 Marks)**

b. Design a socket and spigot type of cotter joint to connect two rods subjected to steady axial pull of 100 kN. The material used for socket end, spigot end and cotter is cast steel with $\sigma_y = 328.6$ MPa, take FoS as 4 for tension, 6 for shear and 3 for crushing based on tensile yield strength. **(10 Marks)**

Module-4

7 a. Design a triple riveted longitudinal double strap butt joint with unequal strap for a boiler. The inside diameter of the longest course of the drum is 1.3 m. The joint is to be designed for a steam pressure of 2.4 N/mm^2. The working stresses to be used are $\sigma_t = 77$ MPa for plate material in tension, $\tau = 62$ MPa for rivet material in shear, $\sigma_c = 120$ MPa for rivet material in compression. Assume joint efficiency as 81%. **(10 Marks)**

b. Determine the size of rivets required for the bracket shown in Fig. Q7 (b). Take permissible shear stress for the rivet material as 100 MPa. **(10 Marks)**

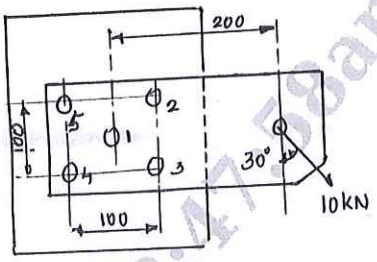

Fig. Q7 (b)

OR

8 a. The following Fig. Q8 (a) shows connections of eccentrically loaded welded joint. The allowable shear stress in the fillet weld using MS bar electrodes can be taken as 80 N/mm^2, find the thickness of the plate. **(10 Marks)**

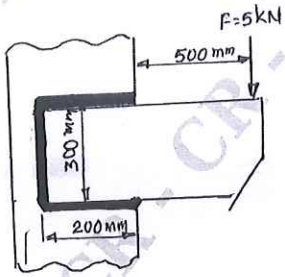

Fig. Q8 (a)

b. A shaft of rectangular cross section is welded to a support by means of fillet welds as shown in Fig. Q8 (b). Determine the size of the weld if the permissible shear stress in the weld material is 75 MPa. **(10 Marks)**

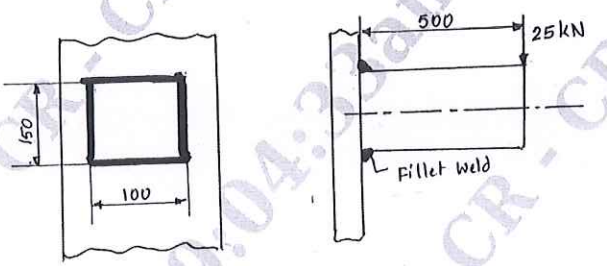

Fig. Q8 (b)

Module-5

9 a. A cylinder head is fastened to the cylinder of a compressor using 6 bolts of M20 size. Bolt material is C20 steel. The maximum fluid pressure is 3.5 MPa, cylinder diameter is 75 mm. A soft gasket is used. Assuming the initial tension required in each bolt is 40 kN, determine the factor of safety. **(10 Marks)**

b. In a hand vice, the screw has double start Acme thread of 25 mm internal diameter and 4 mm pitch. If the length of the lever is 300 mm; the maximum force that can be applied at the end of the lever is 250 N. Determine the force with which the job is held between the jaws of the vice. Take co-efficient of friction at the thread is 0.14, angle of thread $2\theta = 29°$. Neglect collar friction. **(10 Marks)**

OR

10 a. Explain self locking and overhauling. Derive an expression for torque required to lift the load on square threaded screw. **(10 Marks)**

b. A single threaded power screw of 25 mm diameter with a pitch of 5 mm, a vertical load on the screw reaches a maximum load of 500 N. The co-efficients of friction are 0.05 for the collar and 0.08 for the screw. The frictional diameter of the collar is 30 mm. Find the torque required to rise and lower the load. Also find the efficiency of the power screw. **(10 Marks)**

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