CBCS SCHEME

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18AU53

Fifth Semester B.E. Degree Examination, June/July 2025
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Briefly explain the important mechanical properties of metals. **(06 Marks)**

b. A point in a structural member is subjected to plane state of stress as shown in Fig.Q.1(b). Determine the following:

i) Normal and tangential stress intensities at an angle of $\theta = 45°$

ii) Principle stresses σ_1 and σ_2 and their directions.

iii) Maximum shear stress and its plane. **(14 Marks)**

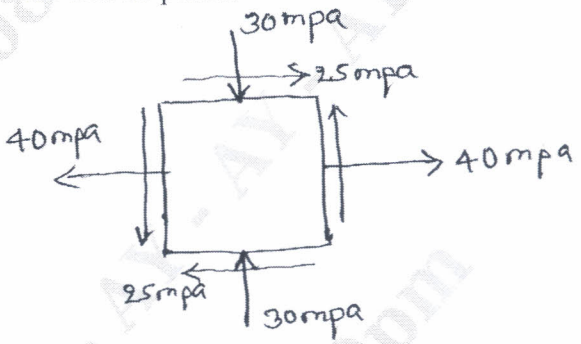

Fig.Q.1(b)

OR

2 a. Explain the following theories of failure :

i) Maximum normal stress theory

ii) Maximum shear stress theory

iii) Distortion energy theory. **(10 Marks)**

b. A plate C-45 steel ($\sigma_{y_t} = 353\,MPa$) is subjected to the following stresses $\sigma_x = 150$ MPa, $\sigma_y = 100$ MPa and $\tau_{xy} = 50$ MPa. Find the factor of safety according to

i) Maximum normal stress theory

ii) Maximum shear stress theory

iii) Distortion energy theory. **(10 Marks)**

Module-2

3 a. Define stress concentration. Describe any three methods used to minimize the stress concentration. **(08 Marks)**

b. Determine the maximum stress in the following cases taking stress concentration into account:

i) A rectangular plate of 50 mm × 80 mm with a hole of 10 mm diameter in the center is loaded in axial tension of 10 km. Thickness of plate is 10 mm.

ii) A circular shaft of 45 mm diameter stepped down to 30 mm diameter having fillet of radius 6 mm subjected to a twisting moment of 150 N-m. **(12 Marks)**

OR

4 a. Define impact load. Derive an expression for impact stress in a axial bar of c/s "A" and length "L" due to the impact load "W" falling from a height "h" from the collar. **(08 Marks)**

b. A steel rod (SAE oil quenched σ_{ut} = 1089.5 MPa, σ_{yt} = 689.4 MPa, σ_{en} = 427.6 MPa) is subjected to a tensile load which varies from 120 KN to 40 KN. Design the safe diameter of the rod using soderberg criteria. Adopt Fosas 2, stress concentration factor as unity. Correction factor for load, size and surface as 0.75, 0.85 and 0.91 respectively. **(12 Marks)**

Module-3

5 a. A 45 mm diameter shaft is made of steel with yield strength of 400 MPa. A parallel key of size 14 mm wide and 9 mm thick made of steel with yield strength of 340 MPa. Find the required length of key if the shaft is loaded to transmit the maximum permissible torque. Design based on maximum shear stress theory and take FOS as 2. **(08 Marks)**

b. A cast iron protective type flange coupling is used to connect two shafts of 80 mm diameter. The shafts runs at 250 rpm transmit a torque of 4300 N-m. The permissible shear stress for shaft and bolt material is 50 MPa and permissible shear stress for flange is 8 MPa. Design the bolts, hub and flange for coupling. **(12 Marks)**

OR

6 A commercial shaft 1 meter long supported between bearings has a pulley of 600 mm diameter weighing 1 kN driven by a horizontal belt drive keyed to the shaft at a distance of 400 mm to the left of the right bearing and receives 25 KW at 1000 rpm. Power from the shaft is transmitted from 20° spur pinion of a pitch circle diameter 200 mm which is mounted at 200 mm to the right of the left bearing to a gear such that tangential force on gear acts vertically upwards. Take the ratio of the belt tension is 3. Determine the standard size of the shaft based on maximum shear stress theory. Assume c_m = 1.75, c_t = 1.25. **(20 Marks)**

Module-4

7 a. Explain in detail various possible modes of failure of riveted joints. **(06 Marks)**

b. Design a double riveted butt joint with two equal cover plates for the longitudinal seam of 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 of 90 N/mm^2, allowable crushing stress of 140 N/mm^2 and an allowable shear stress in the rivet of 50 N/mm^2. **(14 Marks)**

OR

8 a. What are the advantages of welded joints over riveted joints? **(06 Marks)**

b. Determine the load carrying capacity for the joint shown in Fig.Q.8(b). The allowable stress in the 20 mm diameter rivet is 100 N/mm^2. **(14 Marks)**

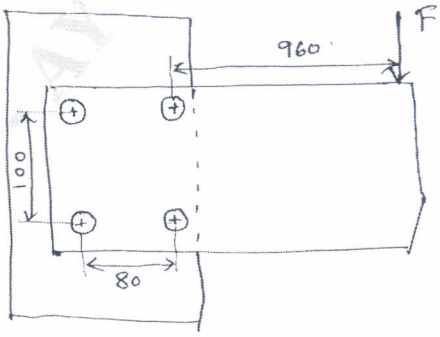

Fig.Q.8(b)

Module-5

9 a. Obtain an expression for torque required to lift the load on a square threaded screw. **(10 Marks)**

b. A flat circular plate is used to close the flanged end of a pressure vessel of internal diameter 300 mm. The vessel carries a fluid at a pressure of 0.7 N/mm^2. A soft copper gasket is used to make the joint leak proof. Twelve bolts are used to fasten the cover plate onto the pressure vessel. Find the size of bolts so the stress in the bolts is not to exceed 100 N/mm^2. **(10 Marks)**

OR

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

b. A split nut used with a lead screw is propelled at a speed of 5m/min, against a load of 20 kN, along the spindle of square thread having a 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 drive. **(14 Marks)**

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