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10ME52

Fifth Semester B.E. Degree Examination, June/July 2018

Design of Machine Elements – I

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of design data hand book is permitted.***

PART – A

1 a. What are the basic requirements of machine elements? Explain briefly. **(04 Marks)**

b. The state of stress at a point in a strained member is shown in Fig.Q1(b). The tensile principal stress is known to be 84 N/mm^2. Determine:
i) Maximum shearing stress at the point and orientation of its plane
ii) Shearing stress τ_{xy}.

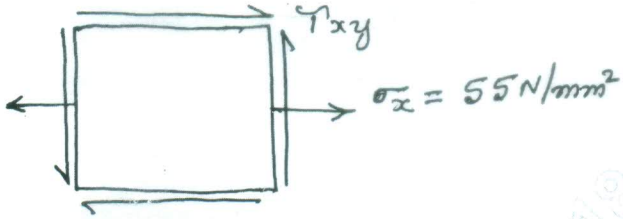

Fig.Q1(b) **(08 Marks)**

c. A bar of 50 mm diameter fixed at one end is subjected to a torsional load of 1 kN-m in addition to an axial pull of 15 kN. Determine the principal stresses if the length of the shaft is 250 mm. **(08 Marks)**

2 a. Explain the following theories of failure and state when they are used:
i) Maximum principal stress theory.
ii) Maximum shear stress theory. **(05 Marks)**

b. Determine the maximum stress induced in the semi circular grooved shaft in Fig.Q2(b) if it is subjected to :
i) An axial load of 40 kN
ii) A bending moment of 400 Nm
iii) A twisting moment of 500 Nm.

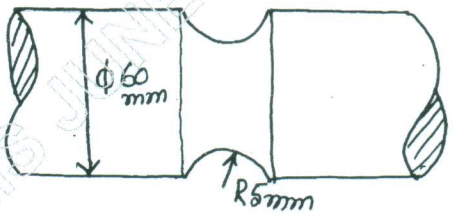

Fig.Q2(b) **(10 Marks)**

c. Derive an expression for stress induced in a rod due to the axial impact of a weight 'W' dropped from a height 'h' on to a collar attached at the free end of the rod. What is the stress due to suddenly applied load? **(05 Marks)**

3 a. Derive Goodman's relation. **(05 Marks)**

b. A steel cantilever member shown in Fig.Q3(b) is subjected to a transverse load at its end that varies from 45 N up to 135 N down as an axial load varies from 110 N compression to 450 N tension. Determine the required diameter at the change of section for infinite life using a factor of safety of 2. The strength properties of the material are σ_u = 550 MPa, σ_y = 470 MPa and σ_{-1} = 275 MPa. Notch sensitivity index q = 1.

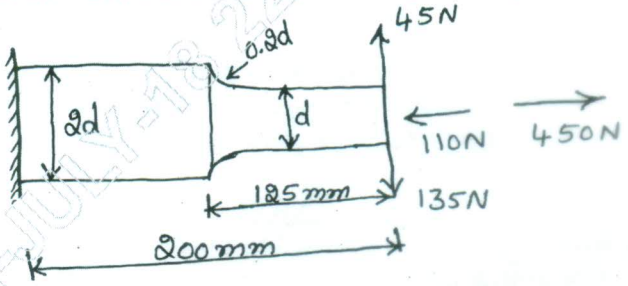

Fig.Q3(b) **(15 Marks)**

4 a. 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 safe copper gasket is used to make the joint leak proof. Twelve bolts are used to fasten the cover plate on to the pressure vessel. Find the size of bolts so that the stress in the bolts is not to exceed 100 N/mm^2. **(08 Marks)**

b. The structural connection shown in Fig.Q4(b) is subjected to an eccentric load P of 10 kN with an eccentricity of 500 mm. The centre distance between bolts at 1 and 3 is 150 mm and the centre distance between bolts at 1 and 2 is 200 mm. All bolts are identical. The bolts are made of plain carbon steel having yield strength in tension of 400 MPa and the factor of safety is 2.5. Determine size of bolts.

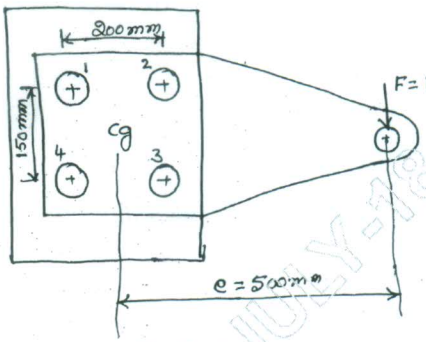

Fig.Q4(b) **(12 Marks)**

PART – B

5 A transmission shaft running at 500 rev/min is supported on bearings 800 mm apart. 20 KW power is supplied to the shaft through a 450 mm diameter pulley which is located 400 mm to the right of right bearing and receives power from a motor placed directly below the shaft. The shaft further transmits this power to a spur gear of 300 mm pitch circle diameter, which is located at 400 mm to the right of left bearing. The gear has 20° involute teeth and ratio of belt tensions is 3:1. The gear drives another gear which is placed directly above the shaft. The gear and pulley are keyed to the shaft. Selecting the material as steel having σ_{ut} = 700 MPa and σ_{yt} = 460 MPa as per ASME code, determine the diameter of shaft. Assume shock factors for bending and torsion as 1.5. **(20 Marks)**

6 a. A rectangular sunk key 14 mm wide × 10 mm thick × 75 mm long is required to transmit 1200 Nm torque from a 50 mm diameter solid shaft. Determine whether the length is sufficient or not if the permissible shear stress and crushing stress are limited to 56 MPa and 168 MPa respectively. **(06 Marks)**

b. Design a flange coupling to connect the shafts of a motor and centrifugal pump for the following specifications Pump output = 3000 litres/minute; total head = 20 m; pump speed = 600 rpm; pump efficiency = 70%. Select C40 steel (σ_y = 328.6 MPa) for shaft and C35 steel (σ_y = 304 MPa) for bolts with factor of safety 2. Use allowable shear stress in cast iron flanges equal to 15 N/mm^2. **(14 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 0.9 MPa. Assume joint efficiency as 75%. Allowable stress in tension for the plate is 83 MPa in compression 138 MPa and shear stress in rivets may be assumed as 55 MPa. Assume chain riveted joint. **(10 Marks)**

b. Determine the size of weld required for the joint shown in Fig.Q7(b), if the allowable shear stress in the weld is limited to 80 N/mm^2.

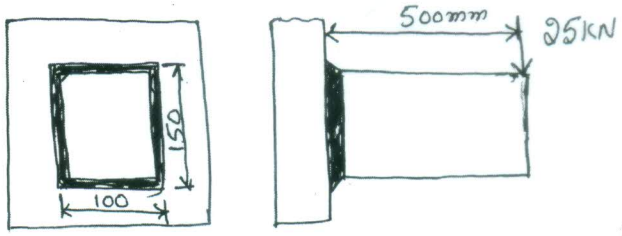

Fig.Q7(b) **(10 Marks)**

8 a. Explain self locking and over hauling 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 120 N/mm^2. The material for the nut is phosphor bronze for which the ultimate strength is 100 N/mm^2 in tension 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 the stresses. Take FOS = 2. Assume 25% overhead for screw rod design. **(16 Marks)**

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