CBCS SCHEME

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17AU53

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

Time: 3 hrs. Max. Marks: 100

Note: ***1. Answer any FIVE full questions, choosing ONE full question from each module.***
2. Use of design data handbook is permitted.
3. Assume missing data suitably.

Module-1

1 a. Draw the stress-strain diagram for a ductile material and show the salient points. **(06 Marks)**

b. A shaft as shown in Fig.Q1(b) is subjected to a bending load of 3 kN, pure torque of 1000 N-m and an axial pulling force of 15 kN. Calculate the stresses at the critical points A and B.

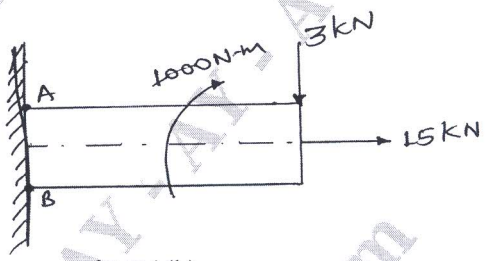

Fig.Q1(b) **(14 Marks)**

OR

2 a. Explain the following theories of failure:
(i) Maximum normal stress theory
(ii) Maximum shear stress theory **(06 Marks)**

b. A rod of circular section is to sustain torsional moment of 300 kN-m and bending moment of 200 kN-m selecting C-45 steel with yield stress 353 N/mm^2 and assuming factor of safety of 3. Determine diameter of rod based on following theories of failure:
(i) Maximum normal stress theory
(ii) Maximum shear stress theory
(iii) Maximum distortion energy theory **(14 Marks)**

Module-2

3 a. Derive an expression for impact stresses due to an axial load. **(06 Marks)**

b. A flat bar shown in Fig.Q3(b) is subjected to an axial load of 100 kN. Assuming that stresses in the bar is limited to 200 N/mm^2. Determine the thickness of the bar.

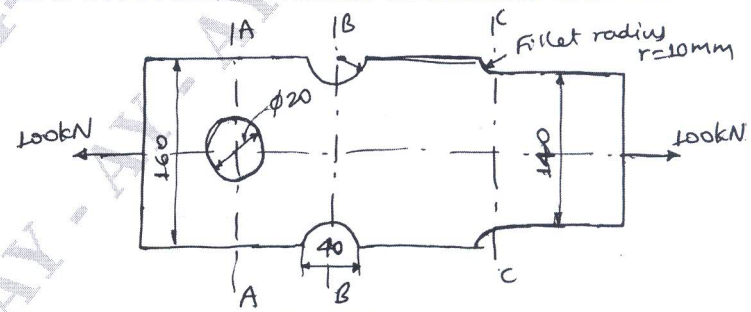

Fig.Q3(b) **(14 Marks)**

OR

4 a. Derive an expression for Soderberg equation. **(06 Marks)**

b. A steel cantilever member as shown in Fig.Q4(b) is subjected to a transverse load at its end that varies from 45 N up to 135 N down and axial load varies from 110 N in compression to 450 N in tension. Determine the required diameter at the change of section for infinite life using FOS = 2. The strength properties of material are σ_u = 550 MPa, σ_y = 470 MPa, σ_{eu} = 275 MPa. The test data indicated that theoretical stress concentration factor for bending and axial load are 1.44 and 1.63 respectively at the change of c/s.

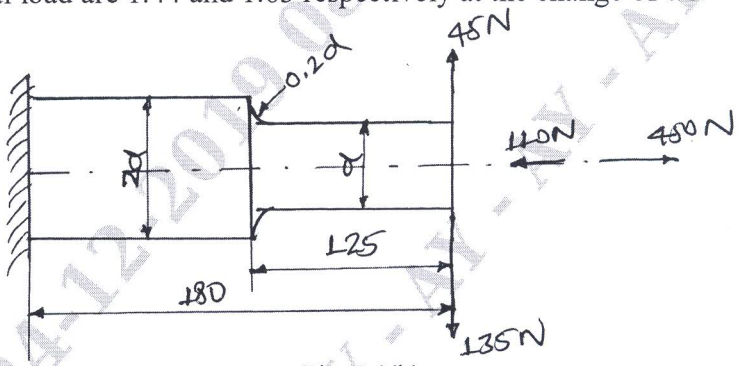

Fig.Q4(b) **(14 Marks)**

Module-3

5 a. Design a cotter joint for an axial load of 50 kN which alternately changes from tensile to compressive, assuming allowable stresses in the components under tension and compression as 52.5 N/mm^2, bearing stress as 63 N/mm^2 and shearing stress as 35 N/mm^2. Sketch neatly the joint and show dimensions. **(15 Marks)**

b. A square key is used to key a gear and a shaft of diameter 35 mm. The hub length of the gear is 60 mm, both key and shaft is made of same material having allowable shear stress of 55 MPa. What are the dimensions of the key according to maximum shear stress theory if 395 N-m of torque is to be transmitted? **(05 Marks)**

OR

6 A uniform circular carbon steel shaft made of SAE 1025 annealed is mounted on two bearings 850 mm apart as shown in the Fig.Q6. The shaft carries a gear A at 200 mm to the right of the left bearing and a pulley B at 250 mm to the left of the right bearing. The gear is subjected to horizontal pressure of 3500 N and a vertical upward pressure of 9600 N. The pulley is driven by a belt with a tension on tight side to be 6000 N and on the slack side to be 2000 N. The shock and fatigue factors for bending and torsion as K_m = 2 and K_t = 1.5 respectively and weight of the pulley to be 1500 N. Design the diameter of the shaft for yield stress taking factor of safety as 3. Draw neatly the sketch with loading and bending moment diagrams.

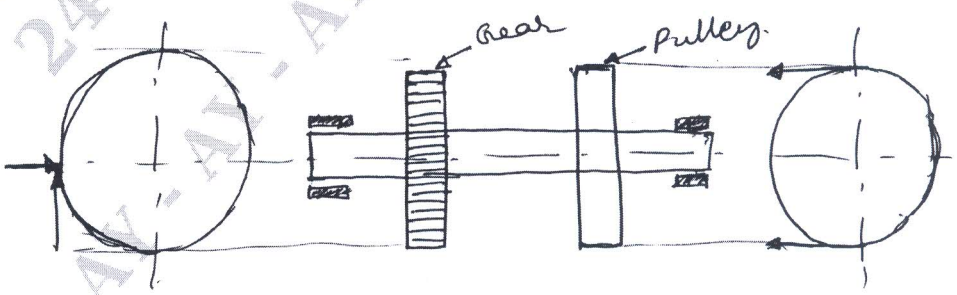

Fig.Q6 **(20 Marks)**

Module-4

7 a. Design a double riveted butt joint with two cover plate 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 compressive stress of 140 N/mm^2, allowable tensile stress in the plate is 90 N/mm^2 and allowable shear stress in the rivet of 56 N/mm^2. **(10 Marks)**

b. A bracket is riveted to a column by 6 rivets of equal size as shown in Fig.Q7(b). It carries a load of 60 kN at a distance of 200 mm from the centre of the column. If the maximum shear stress in the rivet is limited to 150 N/mm^2. Determine the diameter of rivet. Following figure shows the arrangement Fig.Q7(b).

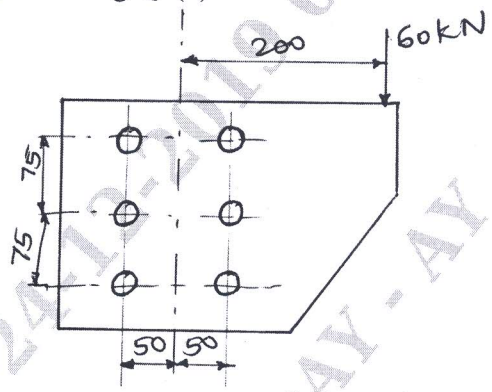

Fig.Q7(b) All dimensions are in mm. **(10 Marks)**

OR

8 a. Determine the size of the weld required for a plate welded to a steel column and loaded as shown in Fig.Q8(a). The allowable shear stress in the weld is limited to 80 MPa at the throat section.

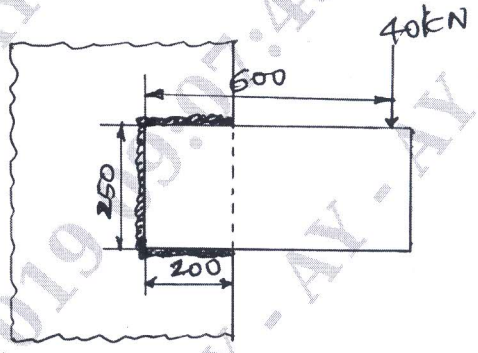

Fig.Q8(a) All dimensions are in mm. **(14 Marks)**

b. A 50 mm diameter solid shaft is welded to a flat plate by 10 mm fillet weld. Find the maximum torque that the welded joint can sustain if the maximum shear stress intensity in the weld material is not to exceeds 80 MPa. Refer the Fig.Q8(b).

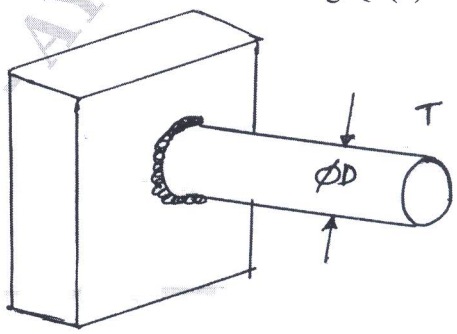

Fig.Q8(b) **(06 Marks)**

Module-5

9 a. The structure in Fig.Q9(a) is subjected to eccentric load P = 10 kN with eccentricity of 500 mm. All holes are identical mode of carbon steel having yield strength in tension is 400 MPa and factor of safety is 2.5. Determine size of bolt.

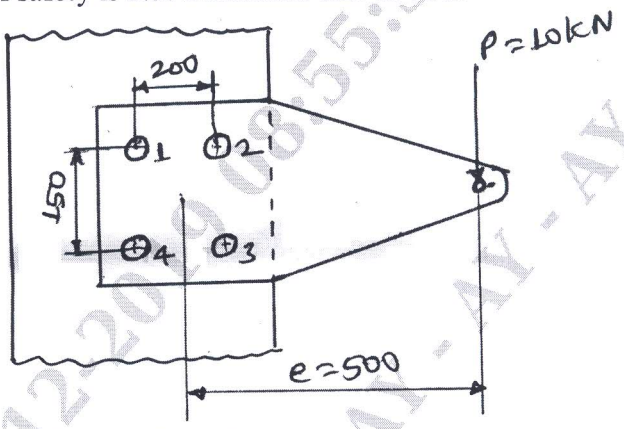

Fig.Q9(a) **(10 Marks)**

b. A bracket is fixed to wall by 4 bolts and loaded as shown in Fig.Q9(b). Calculate the size of bolts if the load is 10 kN and allowable shear stress in bolt material is 40 MPa.

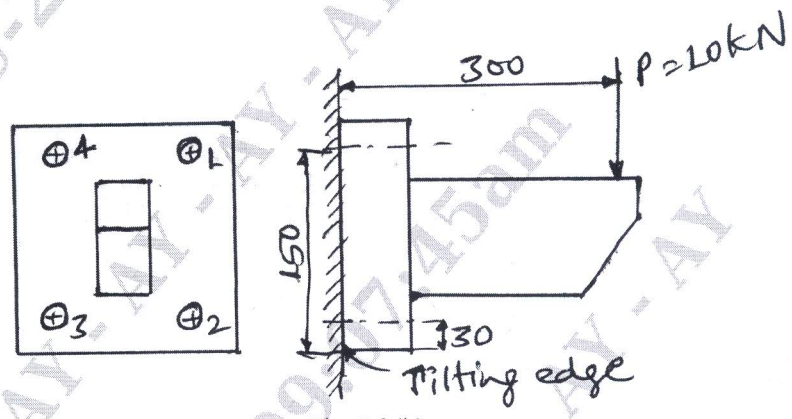

Fig.Q9(b) **(10 Marks)**

OR

10 a. Derive an expression for torque required to raise a load in power screws. **(06 Marks)**

b. A machine slide weighing 20 kN is raised by a double start square threaded screw at the rate of 0.84 m/min. Take $\mu = 0.12$ and $\mu_c = 0.14$. The outside diameter of the screw is 44 mm and the pitch is 7 mm. The outside and inside diameter of the collar at the end of the screw are 58 mm and 32 mm respectively. Calculate the power required to drive slide. If the allowable shear stress in the screw is 30 MPa, is the screw strong enough to sustain load. **(14 Marks)**

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