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**Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024**

## 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. Missing data, if any, may be suitably assumed.

### Module-1

- 1 a. Write short notes on :
- i) Failure of brittle materials
  - ii) Failure of ductile materials
  - iii) Criteria for selection of FOS. (08 Marks)
- b. A point in a structural member subjected to plane stress as shown in Fig.Q1(b). Determine the following :
- i) Normal and tangential stress
  - ii) Principal stresses and their direction
  - iii) Maximum shear stress and the direction of the plane on which it occur.

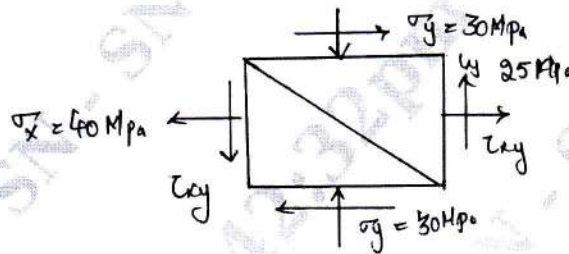


Fig.Q1(b)

(12 Marks)

OR

- 2 a. Describe the theories of failure – with generation expressions. (08 Marks)
- b. A rod of circular section is to sustain a torsional moment 300kNm and bending moment 200 kNm selecting C45 steel ( $\sigma_y = 353\text{MPa}$ ) and assuming factor of safety = 3. Determine the diameter of rod as per following theories of failure.
- i) Maximum shear stress theory
  - ii) Distortion energy theory. (12 Marks)

### Module-2

- 3 a. With neat sketch, explain the methods of reducing stress concentration. (10 Marks)
- b. Find the maximum stress induced in the following cases taking stress concentration into account.

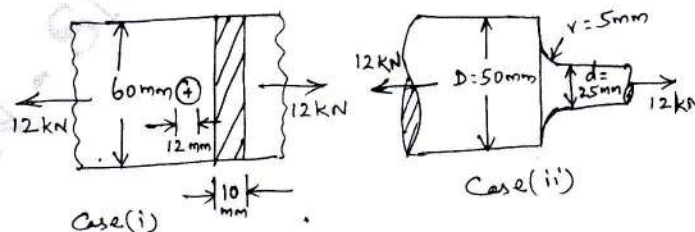


Fig.Q3(b)

1 of 3

(10 Marks)

OR

- 4 a. Write short notes on Notch Sensitivity. (10 Marks)
- b. Determine the thickness of a 120 mm wide uniform plate for safe continuous operation if the plate is to be subjected to a tensile load that has a maximum value of 250 kN and a minimum value of 100 kN. The properties of the plate material are as follows :
- Endurance limit stress = 225 MPa
  - Yield point stress = 300 MPa
  - Factor of safety = 1.5
- (10 Marks)

**Module-3**

- 5 a. Design a square key for a gear shaft of diameter 25mm. 20KW at 1000rpm is transmitted from the shaft to the gear.  $\sigma_{yt} = 450\text{MPa}$  ; FOS = 3 ;  $\sigma_{yt} = \sigma_{yc}$ . Determine the dimensions of the key. (10 Marks)
- b. Design and sketch the assembly of a knuckle joint to connect two mild steel rods subjected to an axial pull of 100kN. The allowable stresses for rods and pin are 100MPa, 130MPa, 60MPa in tension crushing and shear respectively. The bending of the pin is prevented by selection of proper fit. (10 Marks)

OR

- 6 a. Prove that a Hollow shaft is always stronger than a solid shaft with usual notations. (08 Marks)
- b. A shaft is mounted between bearings located 9.5m apart and transmits 10,000KW at 90rpm. The shaft weighs 66000N, has outside diameter = 450mm and inner diameter = 300mm. Determine the stress induced in the shaft and the angular deflection between the bearings. Do not neglect the weight of the shaft. ( $K_b = 1.5$  and  $K_f = 1.0$ ). (12 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  $0.95\text{ N/mm}^2$ . Assume an efficiency of 75%. Allowable compressive stress of  $140\text{ N/mm}^2$ , allowable tensile stress in the plate is  $90\text{ N/mm}^2$  and allowable shear stress in the rivet of  $56\text{ N/mm}^2$ . (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  $150\text{ N/mm}^2$ . Determine the diameter of rivet. Following figure shows the arrangement Fig.Q7(b).

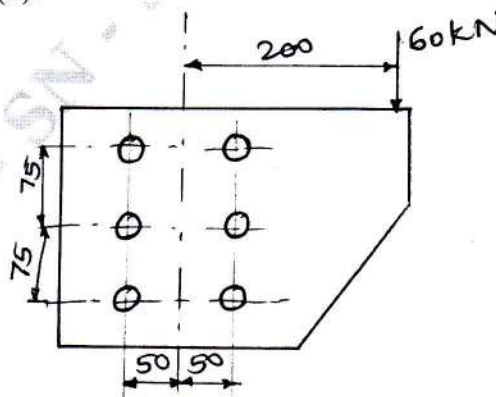


Fig.Q7(b) All dimensions are in mm.

(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.

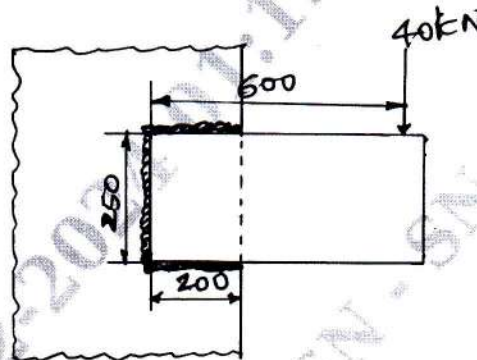


Fig.Q8(a) All dimensions are in mm. (14 Marks)

- 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 exceed 80 MPa. Refer the Fig.Q8(b).

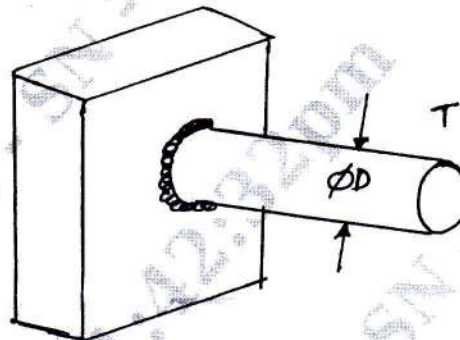


Fig.Q8(b) (06 Marks)

**Module-5**

- 9 a. Explain the types of threads and its terminologies. With a neat sketch. (10 Marks)  
 b. Derive an expression for torque required to lift the load on square threaded screw. (10 Marks)

OR

- 10 Design a screw jack with a lift of 300mm to lift a load of 50kN. Select C-40 steel ( $\sigma_y = 328.6\text{MPa}$ ) for the screw and soft phosphor bronze ( $\sigma_{ut} = 345\text{MPa}$  and  $\sigma_y = 138\text{MPa}$ ) for nut. (20 Marks)

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