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CBCS SCHEME

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17ME54

Fifth Semester B.E. Degree Examination, June/July 2023
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 Hand book is permitted.
3. Assume any missing data suitably.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Explain the phases of mechanical engineering design process. **(06 Marks)**

b. A point in a plate grider is subjected horizontal tensile stress of 100 MPa and vertical shear stress of 60 MPa. Find the magnitude of principal stress and its location. **(06 Marks)**

c. Determine maximum normal stress and maximum shear stress at section A – A for crack pin as shown in Fig.Q1(c) when a load of 10 kN is assumed to be concentrated at centre of crank pin.

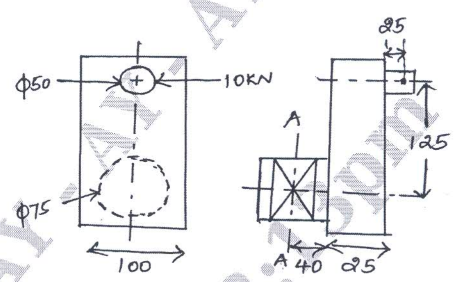

Fig.Q1(c) **(08 Marks)**

OR

2 a. Explain any five methods to reduce stress concentration in mechanical components. **(05 Marks)**

b. A 50mm diameter steel rod supports 9 kN load and in addition is subjected to a torsional moment of 100 N-m as shown in Fig.Q2(b). Determine maximum tensile and maximum shear stress.

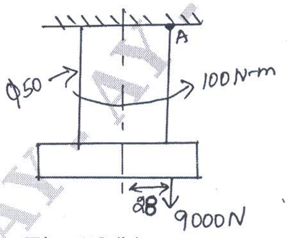

Fig.Q2(b) **(07 Marks)**

c. A stepped shaft as shown in Fig.Q2(c) is subjected to transverse load. Shaft is made of steel with ultimate strength 400 MPa. Determine diameter 'd' taking FOS = 2.

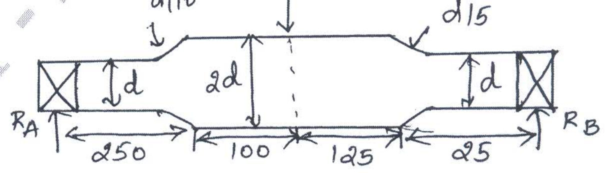

Fig.Q2(c) **(08 Marks)**

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Module-2

3 a. A unknown weight falls from a height of 20mm on to a collar rigidly attached to lower end of vertical bar 2m long and 500 sq-mm section. If maximum instantaneous extension is known to be 2mm, what is corresponding stress and value of unknown weight. Take E = 200 GPa. [Refer Fig.Q3(a)]

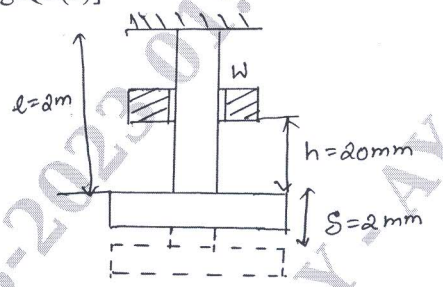


Fig.Q3(a) **(10 Marks)**

b. A elevator car carrying a load of 10 kN is descending by means of steel rope at speed of 1 m/sec. The C/S area of rope is 400 mm^2. Rope is suddenly brought to rest by braking after 30 secs of descent. Calculate stress induced in rope due to sudden stoppage, if $E_{rope} = 80 \times 10^3$ N/mm^2. **(10 Marks)**

OR

4 a. Explain the factors affecting Endurance limit. **(06 Marks)**

b. A steel shaft is subjected to a bending moment that varies from 100 Nm to 200 Nm and transmits 10 kW at 150 rpm. Torque varies over a range of ±40%. Shaft is made of steel with yield strength of 400 MPa and endurance stress 300 N/mm^2. Consider size factor as 1.2, Surface factor 0.9 , FOS = 5, K_{ft} = 1.94. Determine diameter of shaft for infinite life. **(14 Marks)**

Module-3

5 A shaft is supported by bearings placed 1100 mm apart. A pulley of diameter 620mm is keyed at 400mm to the right from left hand bearing and this drives a pulley directly below it with maximum tension of 2.75 kN. Another pulley of diameter 400mm is placed 200mm to left of right hand bearing and is driven with motor placed horizontally to the right. Angle of contact of pulleys is 180° and $\mu = 0.3$. Find diameter of shaft. Assume $C_m = 3.0$, $C_t = 2.5$, $\sigma_y = 190$ MPa , $\sigma_u = 300$ MPa. **(20 Marks)**

OR

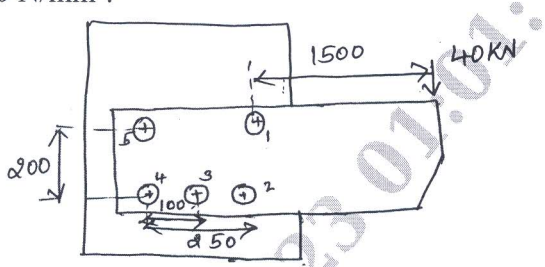
6 a. Design a socket and spigot type cotter joint to sustain axial load of 100 kN. Material selected for joint has following design stresses $\sigma_t = 100$ N/mm^2 ; $\sigma_c = 150$ N/mm^2 ; $\tau = 60$ N/mm^2. **(10 Marks)**

b. In a flange coupling used to connect two co-axial shafts of diameter 80mm to transmit 60 kW at 200 rpm, 6bolts of M14 × 1.5 are used on a bolt circle diameter of 240mm. Hub diameter is 150mm and flange thickness is 20mm. Find (i) Shear stress induced in shaft (ii) Shear stress induced in bolt (iii) Shear stress induced in key if allowable bearing stress on key is 80 MPa. (iv) Shear stress induced in flange. **(10 Marks)**

Module-4

7 a. A double riveted rap joint is to be made between 9mm plates. If safe working stress in tension, shear and crushing are 80 N/mm^2, 60 N/mm^2 and 120 N/mm^2 respectively. Design riveted joint considering it to be chain riveted. **(10 Marks)**

b. Determine the diameter of rivet for a joint loaded as shown in Fig.Q7(b). Allowable stress in rivets is 100 N/mm^2.



Distance between 3rd and 4th rivet is 100mm
Distance between 2nd and 4th rivet is 250mm

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

OR

8 a. A plate of 80mm wide and 10mm thick is to be welded to another plate by means of parallel fillet welds. Plates are subjected to a load of 50 kN. Find the length of weld so that maximum stress does not exceed 50 MPa. Consider joint under static and dynamic loading. [Refer Fig.Q8(a)]

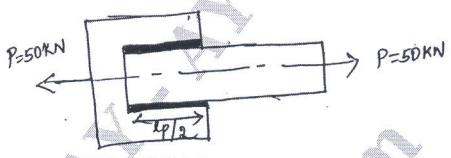


Fig.Q8(a) **(10 Marks)**

b. Determine size of weld required for joint as shown in Fig.Q8(b). If allowable shear stress in weld is 80 N/mm^2.

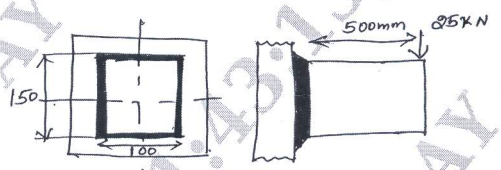


Fig.Q8(b) **(10 Marks)**

Module-5

9 a. A M/O steel bolt of 125mm long is subjected to impact load. Kinetic energy absorbed by bolt is 2.5J. Determine
i) Stress in shank of bolt if there is no threaded portion between nut and bolt head
ii) Stress in shank if area of shank is reduced to that of the root area of thread or entire length of bolt is threaded. **(10 Marks)**

b. The structural connection as shown in Fig.Q9(b) is subjected to eccentricity head P of 10 kN with eccentricity of 500 mm. Centre distance between bolts 1 and 3 is 150mm and between bolts 1 and 2 is 200mm. All bolts are identical. Yield strength of given material is 400 MPa and FOS = 2.5. Find size of bolts.

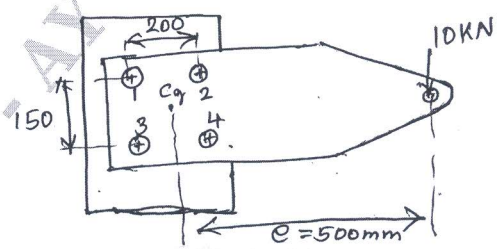


Fig.Q9(b) **(10 Marks)**

OR

10 a. Derive the relation for torque required to lift the load on square threaded screw. **(08 Marks)**

b. A weight of 500 kN is raised at a speed of 6m/min by two screw rods with square threads of 50×8 cut on them. Two screw rods are driven through bevel gear drives by a motor. Determine

i) Torque required to raise the load
ii) Speed of rotation of screw rod assuming threads are double start.
iii) Maximum stress induced on C/S of rod
iv) Efficiency of screw drive
v) Length of nuts for purpose of supporting load
vi) Check overhaul. **(12 Marks)**

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