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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fifth Semester, B.E. - Mechanical Engineering

Semester End Examination; February / March - 2022

Design of Machine Elements - I

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Explain basic design concept, failure theories and Solve for stresses induced in simple machine elements subjected to static loads.

CO2: Explain concepts of fatigue loading and impact loading and model simple machine elements under fatigue loading conditions.

CO3: Solve for the sizes and stresses in transmission shafts and Muff coupling and rigid flange coupling.

CO4: Explain threaded joints and power screws and solve for the efficiency of joints.

CO5: Classify methods of riveting and welded joints and Analyze the joint efficiency for boiler and structural applications.

Note: ***I) PART - A*** *is compulsory.* ***Two*** *marks for each question.*

II) PART - B*: Answer any* ***Two*** *sub questions (from a, b, c) for Maximum of* ***18 marks*** *from each unit.*

Q. No.	Questions	Marks	BLs	COs	POs
	I : PART - A	**10**			
1 a.	Define codes and standards used in machine design.	2	L1	CO1	PO1,2
b.	Define high cycle fatigue and low cycle fatigue.	2	L1	CO2	PO1,2
c.	List the properties of shaft material.	2	L1	CO3	PO1,2
d.	List the importance of screw threads?	2	L1	CO4	PO1,2
e.	What are the advantages of welded joints over riveted joints?	2	L1	CO5	PO1,2
	II : PART - B	**90**			
	UNIT - I	**18**			
1 a.	A 50 mm diameter steel rod supports a 9 kN load and in addition subjected to a torsional load of 100 N-m as shown in Fig. Q1(a). Determine the maximum tensile and maximum shear stress.	9	L3	CO1	PO1,2,3
b.	A flat plate is subjected to a tensile force of 5 kN is as shown in Fig. Q1(b). The plate material is grey cast iron good. Determine the thickness of the plate. FOS is 2.5 ($\sigma_u = 166MPa$).	9	L3	CO1	PO1,2,3
c.	A machine element is subjected to following stresses: $\sigma_x = 60MPa$, $\sigma_y = 45MPa$ *and* $\tau_{xy} = 30MPa$. Find the FOS if it is made of C45 steel having yield stress at 353 MPa, using following theories: i) Maximum normal stress theory ii) Maximum shear stress theory iii) Distortion energy theory	9	L3	CO1	PO1,2,3

Contd... 2

UNIT - II **18**

2 a.	A cantilever beam made of cold drawn carbon steel $(\sigma_u = 550MPa), \sigma_y = 470MPa \quad and \ \sigma_G = 275MPa)$ of circular shown in Fig. 2(a) is subjected to load which varies from –F to 3F. Determine the maximum load that the cantilever can withstand for an infinite life using FOS of 2.	12	L3	CO2	PO1,2,3
b.	A weight of 2 kN falls through a height of 2 mm and strikes the collar as shown in Fig. 2(b). The diameter of steel bar is 30 mm and the length of the bar is 500 mm. Take E = 200 GPa. Determine : i) Stress induced in the bar neglecting inertia ii) Stress induced in the bar considering inertia of the bar take specific weight of bar as 78 kN/m^3.	12	L3	CO2	PO1,2,3
c.	Derive an expression for impact stress for axial load.	6	L2	CO2	PO1,2,3

UNIT - III **18**

3 a.	In an axial flow rotary compressor the shaft is subjected to a maximum torque of 1500 N-m and a maximum bending moment of 3000 N-m. Neglecting the axial load on the compressor shaft determine the diameter of shaft. The shear stress in shaft material is limited to 50 MPa. Also design a hollow shaft per above compressor taking inner diameter as 0.6 times the outer diameter. What % of material is saved in hollow shaft? Assume minor shock.	9	L3	CO3	PO1,2,3
b.	Design a muff coupling to transmit 10 kW at 200 rpm. The allowable values of shear stress and compressive stress for the shaft and key material is taken as 60 MPa and 130 MPa respectively. Use allowable shear stress in the cast iron sleeve as 15 N/mm^2, $\eta = 0.75$.	9	L3	CO3	PO1,2,3
c.	Design a rigid flange coupling to transmit 18 kW at 1440 rpm. The allowable shear stress in the cast iron flange is 4 MPa. Take σ_y = 353.4 MPa and σ_u = 518.8 MPa. Use ASME code to design the shaft and key.	9	L3	CO3	PO1,2,3

UNIT - IV **18**

4 a.	The structural connections shown in Fig. Q4(a) 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 FOS is 2.5. Determine size of bolts.	12	L3	CO4	PO1,2,3

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b.	A weight of 500 kN is raised at a speed of 6 m/min by two screw rod with square threads of 50 x 8 cut on them. The two screw rods are driven by bevel gear, determine; i) The torque required to raise load ii) The speed of rotation of screw assuming double start threads iii) The maximum stress induced on the c/s of screw rod iv) The efficiency of screw drive	12	L3	CO4	PO1,2,3
c.	Explain self locking and overhauling in power screws.	6	L2	CO4	PO1,2,3

UNIT - V **18**

5 a.	A double riveted lap joint is to be made between 9 mm plates. If the safe working stresses in tension, crushing and shear are 80 N/mm^2, 120 N/mm^2 and 60 N/mm^2 respectively. Design the riveted joint.	10	L4	CO5	PO1,2,3
b.	Determine the size of weld required for an eccentrically loaded weld as shown in Fig. Q5(b). The allowable stresses in the weld is 75 N/mm^2.	10	L3	CO5	PO1,2,3
c.	A plate of 50 mm wide and 10 mm thick is to be welded to another plate by means of transverse fillet weld at the ends. If the allowable tensile stress is 100 N/mm^2, determine the length of the weld.	8	L3	CO5	PO1,2,3

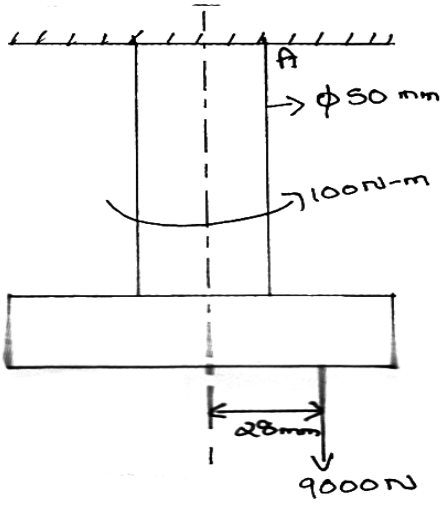

Fig Q1(a)

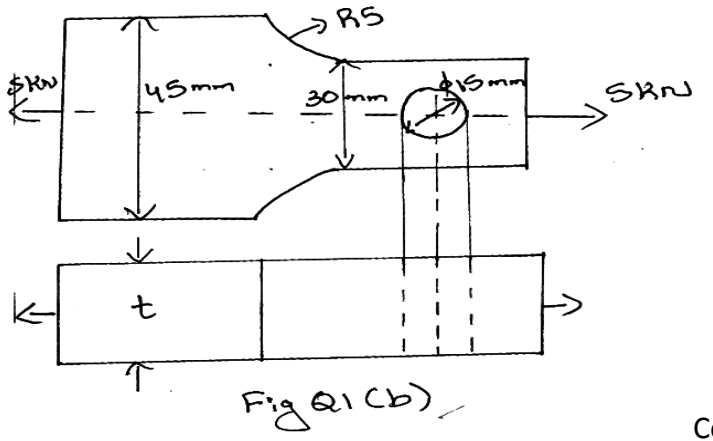

Fig Q1(b)

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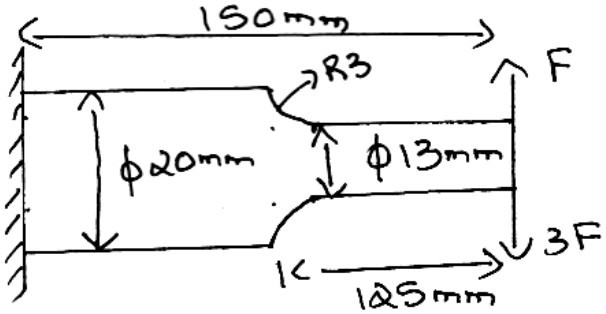

Fig Q2(a)

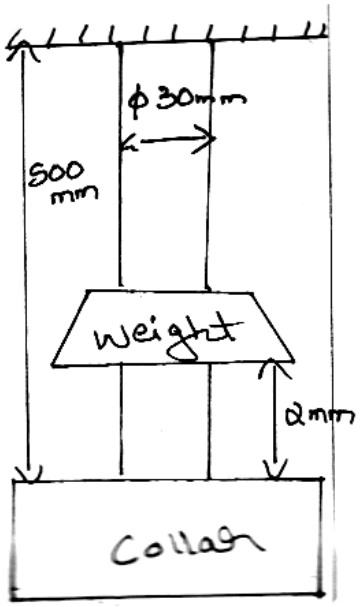

Fig Q2(b)

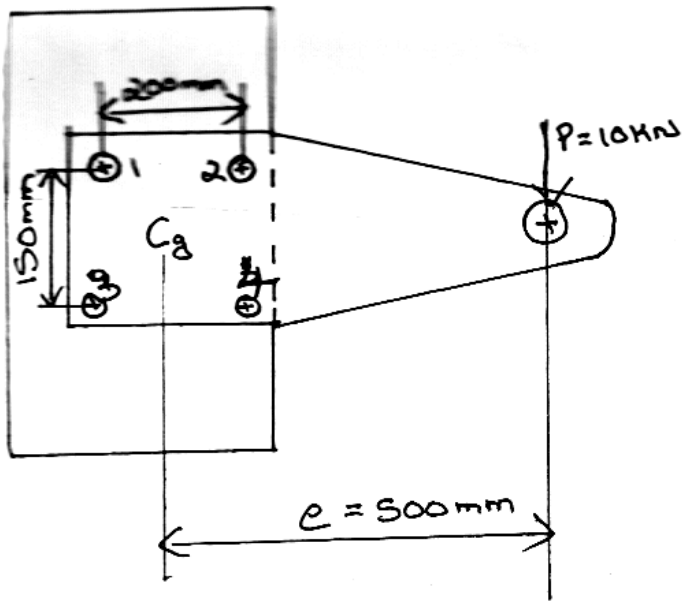

Fig Q4(a)

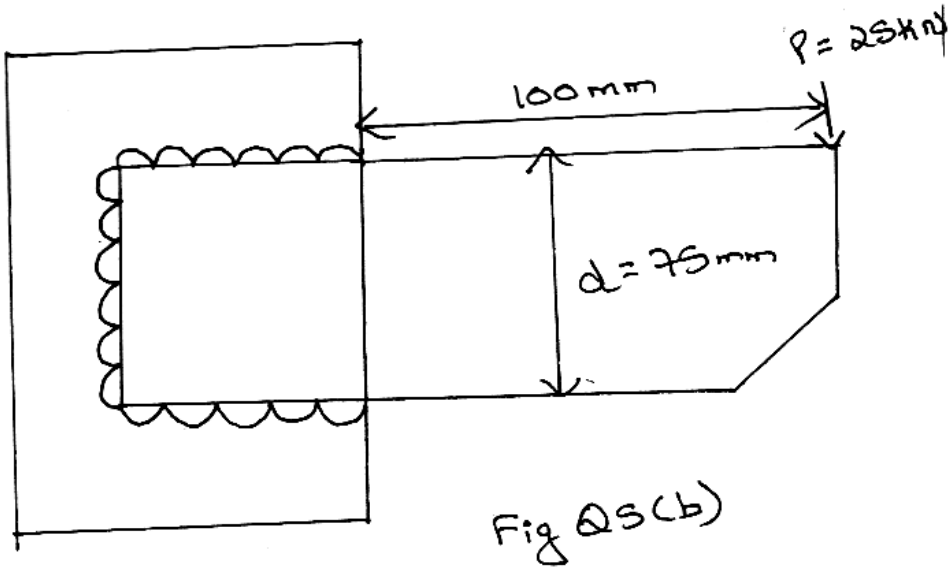

Fig Q5(b)

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