U.S.N | | | | | | | | | | |

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; Feb. - 2021

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.*

***III)** Use of design data hand book is permitted.* ***IV)** Missing data may be suitably assumed.*

Q. No.	Questions	Marks	BLs	COs	POs
	PART - A	**10**			
1 a.	Define factor of safety in design engineering.	2	L1	CO1	PO1
b.	Define fatigue.	2	L1	CO2	PO2
c.	What types of stresses are induced in shafts?	2	L1	CO3	PO3
d.	Define overhauling in power screws.	2	L1	CO4	PO3
e.	List the various ways by which a riveted joint may fail.	2	L1	CO5	PO2
	PART - B	**90**			
	UNIT - I	**18**			
1 a.	A point in a structural member is subjected to a plane stress shown in Fig. 1(a). Determine; i) Normal and tangential stress acting on plane *MN* inclined at an angle 45° ii) Maximum principal stresses and their direction iii) Maximum shear stresses and direction on a plane on which it occurs	10	L3	CO1	PO2

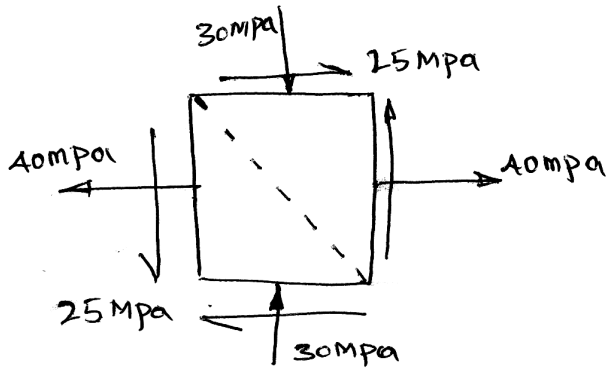

Fig. 1(a)

Contd…2

b. A material has yield strength of 600 MPa. Compute the factor of safety for each of the failure theories for a ductile material. Use following stress states:

i) $\sigma_1 = 420$ MPa $\sigma_2 = 410$ MPa $\sigma_3 = 0$ MPa

ii) $\sigma_1 = 420$ MPa $\sigma_2 = 180$ MPa $\sigma_3 = 0$ MPa

iii) $\sigma_1 = 420$ MPa $\sigma_2 = 0$ MPa $\sigma_3 = -18$ MPa

10 L3 CO1 PO3,1

c. What is mechanical engineering design? List the steps involved in design with block diagram. 8 L2 CO1 PO3,2

UNIT - II **18**

2 a. Determine the diameters of a hollow rod to sustain a twisting moment that fluctuated between 2.5 kN-m and 1.5 kN-m together with a bending moment that fluctuated between +2 kN-m and −2 kN-m. Assume the inner diameter to be 0.6 times the outer diameter. The material for the rod is C40 steel. Assume factor of safety of 2.5. 14 L3 CO2 PO3,2

b. A shaft can transmit a power of 20 kW at 1000 rpm. Actual torque transmitted is ±60% of the mean torque calculated. The shaft is also subjected to a variable bending moment of 500 N-m to 1000 N-m. The maximum bending moment occurs at same instant as that of maximum torque. Determine the diameter of shaft required, selecting SAE 1045 Steel as a material.
Take; FOS as 2, Size factor 0.85 and surface factor 0.8. 14 L3 CO2 PO3,2

c. Derive Soderberg's equation for designing a machine element, to sustain fluctuating loads. 4 L3 CO2 PO3,2

UNIT - III **18**

3 a. A shaft transmitting 100 kW at 300 rpm is made of mild steel. The supported length of the shaft is 3 m. The shaft carries two pulleys each weighing 1500 N supported at a distance of 1 m from the ends respectively. Determine the diameter of the shaft (Assume $\tau_{max} = 60$ MPa). 9 L3 CO3 PO3,1

b. A shaft supported at the ends in ball bearings carries a straight tooth spur gear at its mid-span and is to transmit 7.5 kW at 280 rpm. The pitch circle diameter of the gear is 150 mm. The distance between the centre line of bearing and gear are 100 mm each. If the shaft is made of steel and allowable shear stress is 40 MPa, determine the diameter of the shaft. The pressure angle of the gear may be taken as 20°. 9 L3 CO3 PO3,4

c. Determine the diameter of the shaft required to transmit 60 kW at 1000 rpm. The allowable shear stress may be taken as 80 MPa. Replace the solid shaft with a hollow one assuming a diameter ratio of 0.75 made of the same material and factor of safety. 9 L3 CO3 PO3,2

Contd…3

UNIT - IV **18**

4 a. A cover plate is bolted on to flanged end of a pressure vessel of bore 200 mm and is subjected to an internal pressure of 10 MPa. The number of bolts used is '6'. Selecting carbon steel C40 as material for the bolts, determine the size of the bolts also considering the initial tension for the case metal to metal joint. Assume FOS = 2.5. 9 L3 CO4 PO3,4

b. A power screw for a jack has square threads of proportion 50 x 42 x 8. The coefficient of friction at the threads is 0.01 while that at the collar is 0.12. Determine the weight that can be lifted by this jack through a hand level of span 400 mm. 9 L3 CO4 PO3

c. A weight of 500 kN is raised at a speed of 6 m/min by two screw rods of double start square thread of 50 mm major diameter with a pitch of 8 mm. The two screw rods are driven through Bevel gear drives by a motor.

Determine, 9 L3 CO4 PO2

i) The torque required to raise the load

ii) The speed of rotation of the screw rod

iii) The maximum stress induced, on the cross section of the screw rod

UNIT - V **18**

5 a. Design a double riveted butt joint with equal widths of cover plates to join two plate of thickness 10 mm. The allowable stress for the material of the rivets and for the plate are as follows: 9 L3 CO5 PO2

For plate material in tension $\sigma_t = 80$ MPa

For rivet material in compression $\sigma_c = 120$ MPa

For rivet material in shear $\tau = 60$ MPa

b. A bracket carrying a load, of 15 kN is to be welded as shown in Fig. 5(b). Find the size of the weld required, if the allowable shear stress is not to exceed 80 MPa. 9 L3 CO5 PO3

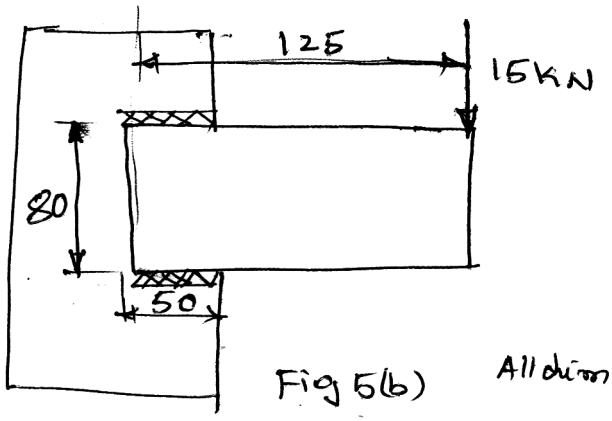

Fig 5(b) All dimension in mm

c. Illustrate with sketches possible modes of failure of a riveted joint. 9 L3 CO5 PO3

* * *