U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

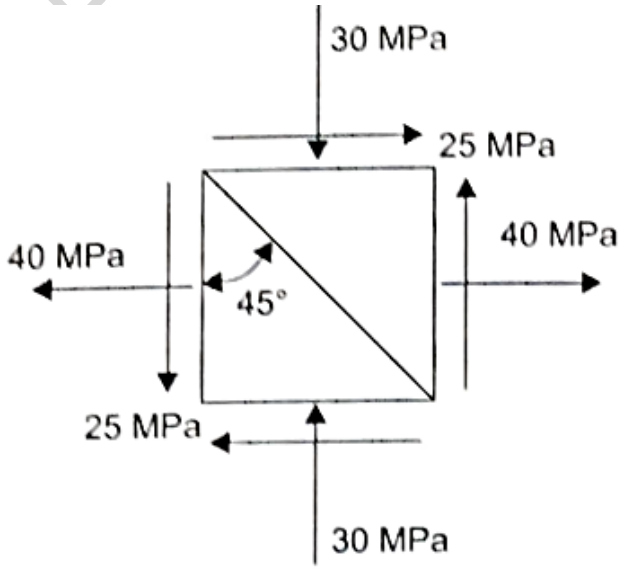
Autonomous Institute Affiliated to VTU

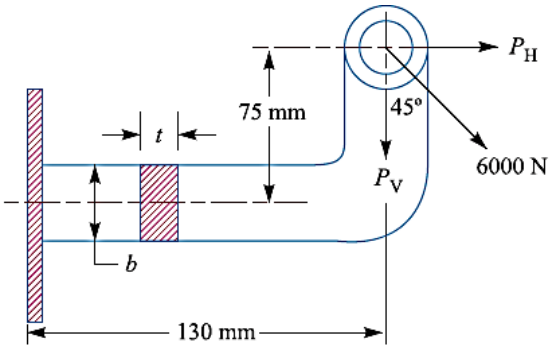
October 2024 Supplementary Examinations

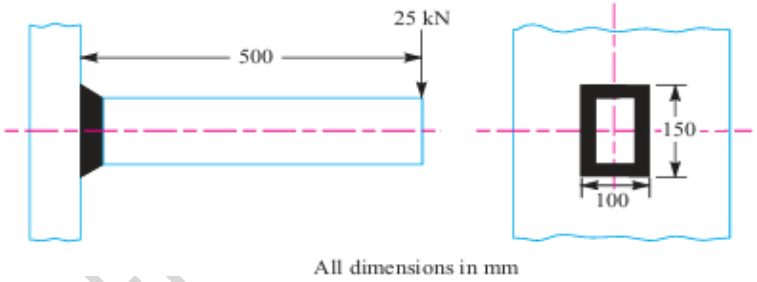
Programme: B.E. **Semester: IV**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 23ME4PCDM1 **Max Marks: 100**
Course: Design of Machine Elements - I

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. **Use of design data handbook is permitted.**

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	CO	PO	Marks
1	a)	A mild steel shaft of 50 mm diameter is subjected to a bending moment of 2000 N-m and a torque T. If the yield point of the steel in tension is 200 MPa, find the maximum value of this torque without causing yielding of the shaft according to (i) the maximum principal stress; (ii) the maximum shear stress; and (iii) the maximum distortion strain energy theory of yielding.	CO1	PO1	**09**
	b)	Discuss the general steps in machine design.	CO1	PO1	**05**
	c)	A point in a structural member is subjected to a plane state of stress as shown in Fig. 1. Determine (i) Normal and tangential stress intensities at an angle of $\theta = 45^o$ (ii) Principal stresses σ_1 and σ_2 (iii) Maximum shear stress.  Fig.1	CO1	PO3	**06**

		OR				
	2	a)	A mild steel bracket as shown in Fig. 2, is subjected to a pull of 6000 N acting at 45° to its horizontal axis. The bracket has a rectangular section whose depth is twice the thickness. Find the cross-sectional dimensions of the bracket, if the permissible stress in the material of the bracket is limited to 60 MPa.  Fig. 2	*CO1*	*PO3*	**10**
		b)	A beam of rectangular cross section has a width of 30 mm and 40 mm depth. The beam is simply supported for the length of 0.9 m. If it is struck by a mass of 10 kg falling through a height of 80 mm, find the instantaneous stress developed. Take E=210 GPa	*CO1*	*PO3*	**10**
			UNIT - II			
	3	a)	Derive an expression for fatigue failure based on Soderberg's criterion.	*CO2*	*PO1*	**08**
		b)	A simply supported beam has a concentrated load at the centre which fluctuates from a value of P to 4 P. The span of the beam is 500 mm and its cross-section is circular with a diameter of 60 mm. Taking for the beam material an ultimate stress of 700 MPa, a yield stress of 500 MPa, endurance limit of 330 MPa for reversed bending, and a factor of safety of 1.3, calculate the maximum value of P. Take a size factor of 0.85 and a surface finish factor of 0.9.	*CO2*	*PO3*	**12**
			UNIT - III			
	4		A solid steel shaft is supported on two bearings 1.8 m apart and rotates at 250 rpm A 20° involute gear D, 300 mm diameter is keyed to the shaft at a distance of 150 mm to the left on the right hand bearing. Two pulleys B and C are located on the shaft at distances of 600 mm and 1350 mm respectively to the right of the left hand bearing. The diameters of the pulleys B and C are 750 mm and 600 mm respectively. 30 kW is supplied to the gear, out of which 18.75 kW is taken off at the pulley C and 11.25 kW from pulley B. The drive from B is vertically downward while from C the drive is downward at an angle of 60° to the horizontal. In both cases the belt tension ratio is 2 and the angle of lap is 180°. The combined fatigue and shock factors for torsion and bending may be taken as 1.5 and 2 respectively.	*CO3*	*PO3*	**20**

			Design a suitable shaft taking working stress as 42 MPa in shear and 84 MPa in tension.			
			OR			
	5	a)	Design a CI flange coupling to connect two shafts of 80 mm diameter. The shaft transmits a torque of 4300 N-m at 250 rpm. The allowable stresses for shafts, keys and bolts are 50 MPa in shear. The allowable shear stress for CI flange is 8 MPa. Design the bolts, hub and flange for the coupling	*CO3*	*PO3*	**10**
		b)	Design socket and spigot type cotter joint to sustain an axial load of 100 kN. The material selected for the joint has the following design stresses: σ_t = 100 MPa, σ_c = 150 MPa and τ = 60 MPa.	*CO3*	*PO3*	**10**
			UNIT - IV			
	6	a)	Design a longitudinal double rivetted double strap Butt joint with unequal cover plates. The internal diameter of boiler shell is 1 m and subjected to a steam pressure of 2.2 MPa. The pitch of the rivets in outer row is double the pitch in the inner row. The allowable tensile stress of the plate is 124 MPa. The allowable shearing and crushing strength of the rivets are 93 MPa and 165 MPa respectively. The resistance in double shear is 1.875 times that of single shear.	*CO3*	*PO3*	**14**
		b)	A rectangular cross-section bar is welded to a support by means of fillet welds as shown in Fig.3. Determine the size of the welds, if the permissible shear stress in the weld is limited to 75 MPa.  Fig. 3	*CO3*	*PO3*	**06**
			UNIT - V			
	7	a)	The cylinder head of a reciprocating air compressor is held in place by 10 bolts. The total joint stiffness is four times the total bolt stiffness. Each bolt is tightened to an initial tension of 5 kN. The total external force acting to separate the joint is 20 kN. Find the size of the bolt so that the stress in the bolt is not to exceed 100 MPa.	*CO3*	*PO3*	**10**
		b)	An electric motor driven power screw moves a nut in a horizontal plane against a force of 75 kN at a speed of 300 mm/min. The screw has a single square thread of 6 mm pitch on a major diameter of 40 mm. The coefficient of friction at screw threads is 0.1. Estimate the power of the motor.	*CO3*	*PO3*	**10**

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