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

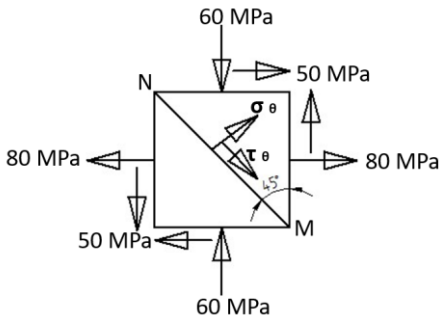
Autonomous Institute Affiliated to VTU

February 2025 Semester End Main Examinations

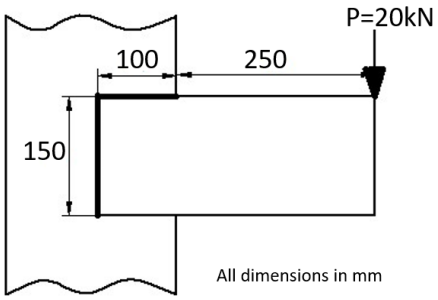
Programme: B.E. **Semester: IV**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 23ME4PCDM1 / 22ME4PCDM1 **Max Marks: 100**
Course: Design of Machine Elements - 1

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)	Define the following: (i) Factor of safety, (ii) Normal stress, (iii) Shear stress & (iv) Principal stresses	*CO1*	*PO1*	**06**
	b)	A point in a structural member subjected to plane stress is shown in **Fig. 1b**. Determine the following: (i) Normal and tangential stress intensities on plane MN inclined at an angle of 45^0, (ii) Principal stresses and their directions and (iii) Maximum shear stress and the directions of the planes on which it occurs.  **Fig. 1b**	*CO1*	*PO2*	**08**
	c)	A shaft is stepped down from 80 mm diameter to 40 mm diameter with a fillet radius of 6 mm. Determine the maximum stress induced in the shaft when subjected to: (i) Bending moment of 200 Nm. (ii) Twisting moment of 400 Nm.	*CO1*	*PO2*	**06**
		OR			
2	a)	List the factors which influence the selection of a suitable material for a machine element and discuss any four.	*CO1*	*PO1*	**06**
	b)	A rod of circular section is to sustain a torsional moment of 300 kNm and bending moment of 200 kNm. Selecting C45 steel (σ_{yt} = 353 MPa) and assuming factor of safety as 3,	*CO1*	*PO2*	**08**

			determine the diameter of rod according to : (i) Maximum principal stress theory of failure, (ii) Maximum shear stress theory of failure & (iii) Maximum distortion energy theory of failure.			
		c)	A beam of 300 mm depth 'I' section is resting on two supports 5 m apart. It is loaded by a weight of 5000 N falling through a height 'h' and striking the beam at midpoint. Moment of inertia of the section is 9.6×10^7 mm^4. Modulus of elasticity $E=21 \times 10^4$ N/mm^2. Determine the permissible value of 'h' if the stress is limited to 130 N/mm^2.	*CO1*	*PO2*	**06**
			UNIT - II			
	3	a)	Derive the modified Soderberg's equation.	*CO2*	*PO1*	**06**
		b)	A piston rod is subjected to a maximum reversed axial load of 110 kN. It is made of steel having an ultimate stress of 900 N/mm^2 and the surface is machined. The average endurance limit is 50% of the ultimate strength. Take the size correction coefficient as 0.85, surface correction coefficient as 0.78 and factor of safety as 1.75. Using Goodman relation determine the diameter of the rod.	*CO2*	*PO2*	**14**
			OR			
	4	a)	Derive the Goodman's equation for infinite life under fatigue loading.	*CO2*	*PO1*	**06**
		b)	A steel rod of ultimate strength 600 N/mm^2 and yield strength 400 N/mm^2 is subjected to a cyclic torque ranging from +350 N-m to -100 N-m. Calculate the diameter of rod. Torsional yield stress = 70% σ_y. Average endurance limit = 50% σ_u. Shear stress concentration factor = 1.3. Factor of safety = 1.8. Size correction coefficient = 0.85.	*CO2*	*PO2*	**14**
			UNIT - III			
	5	a)	Write the ASME code for shaft design.	*CO3*	*PO1*	**02**
		b)	A horizontal piece of commercial shafting is supported by two bearings 1.5 m apart. A keyed gear 20^0 involute and 175 mm in diameter is located 400 mm to the left of the right bearing and is driven by a gear directly behind it. A 600 mm diameter pulley is keyed to the shaft 600 mm to the right of the left bearing and drives a pulley with a horizontal belt directly behind it. The tension ratio of the belt is 3 to 1, with the slack side on top. The drive transmits 45 kW at 330 rpm. Take $K_b = K_t = 1.5$. Calculate the necessary diameter of the shaft and angular deflection in degrees. Take allowable shear stress as 40 MPa and $G = 80 \times 10^9$ N/m^2.	*CO3*	*PO3*	**18**
			OR			
	6	a)	Design a socket and spigot type cotter joint to sustain an axial	*CO3*	*PO3*	**10**

			load of 100 kN. The material selected for the joint has an allowable tensile strength of 100 MPa, allowable compressive strength of 150 MPa and an allowable shear strength of 60 MPa.			
		b)	Design a Unprotected type flange coupling to transmit 24 kW at 300 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted is to be 25% greater than the full load torque. The allowable shear stress in the bolt material is 60 MPa and the allowable shear stress in the flange is 40 MPa.	*CO3*	*PO3*	**10**
			UNIT - IV			
	7	a)	Design a double riveted butt joint to connect two plates of 20 mm thickness. The joint is zig – zag riveted and has equal width cover plates. The allowable tensile stress for the plate is 100 MPa. The allowable shear and crushing stresses for rivet material are 60 MPa and 120 MPa respectively. Calculate the efficiency of the joint. The joint should be leak proof.	*CO3*	*PO3*	**10**
		b)	A 16 mm thick plate is welded to a vertical support by two fillet welds as shown in Fig. 6b. Determine the size of weld, if the permissible shear stress for the weld material is 75 MPa.  **Fig.6b**	*CO3*	*PO2*	**10**
			OR			
	8	a)	Design a double riveted butt joint with two equal width cover plates for the longitudinal seam of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.95 N/mm^2. Assume an efficiency of 75%, allowable tensile stress in the plate of 90 N/mm^2, allowable crushing stress of 140 N/mm^2 and an allowable shear stress in the rivet of 56 N/mm^2.	*CO3*	*PO3*	**10**
		b)	A plate of 80 mm width and 10 mm thickness is to be welded to another plate by means of two parallel fillet welds. The plates are subjected to a load of 50 kN. Find the length of weld so that maximum stress does not exceed 50 N/mm^2. Consider the joint under static loading and then under dynamic loading.	*CO3*	*PO2*	**10**
			UNIT - V			
	9	a)	Briefly explain the various types of stresses in threaded fasteners.	*CO3*	*PO1*	**06**
		b)	A bolt in a steel structure is subjected to a tensile load of 9 kN. The initial tightening load on the bolt is 5 kN. Determine the size	*CO3*	*PO2*	**04**

			of bolt taking allowable stress for the bolt material to be 80 MPa and k = 0.05.			
		c)	A triple threaded power screw used in a screw jack, has nominal diameter of 50 mm and a pitch of 8 mm. The threads are square shape and the length of the nut is 48 mm. The screw jack is used to lift a load of 7.5 kN. The coefficient of friction at the threads is 0.12 and the collar friction is negligible. Calculate: (i) Principal shear stress in the screw rod. (ii) Transverse shear stress in the screw and nut. (iii) Unit bearing pressure for threads and (iv) State whether the screw is self-locking?	*CO3*	*PO2*	**10**
			OR			
	10	a)	A flat circular plate is used to close the flanged end of a pressure vessel of internal diameter 300 mm. The vessel carries a fluid at a pressure of 0.7 N/mm^2. A soft copper gasket is used to make the joint leak proof. Twelve bolts are used to fasten the cover plate onto the pressure vessel. Find the size of bolts so that the stress in the bolts is not to exceed 100 N/mm^2.	*CO3*	*PO2*	**08**
		b)	A single start square threaded power screw is used to raise a load of 120 kN. The screw a mean diameter of 24 mm and four threads per 24 mm length. The mean collar diameter is 40 mm. The coefficient of friction is 0.1 for both the thread and the collar. Determine: (i) Major diameter of the screw, (ii) Screw torque required to raise the load, (iii) Overall efficiency & (iv) If collar friction is eliminated, what minimum value of thread coefficient is required to prevent the screw from overhauling?	*CO3*	*PO2*	**12**

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