U.S.N.										

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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

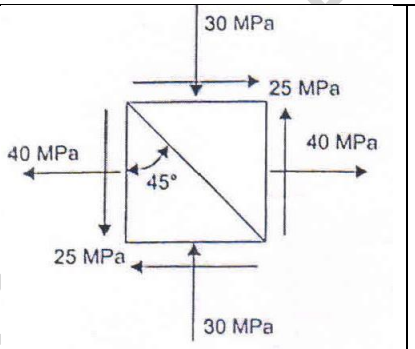
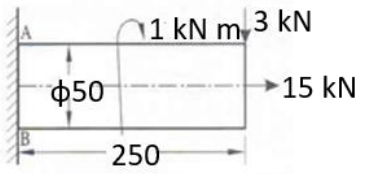
Programme: B.E. **Semester: IV**

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. Use of Design Data Handbooks allowed.
3. Missing data, if any, may be suitably assumed.

		UNIT - I	CO	PO	Marks
1	a)	Explain briefly design codes and standards. Also list any four organizations and societies.	CO1	PO1	**06**
	b)	A point in a structural member subjected to a plane state of stress is shown in **Fig.1b**. Determine the following: (i) Normal and tangential stress intensities on a plane inclined at 45^0, (ii) Principal stresses and their directions and (iii) Maximum shear stress.  **Fig.1b**  **Fig.1c.** All dimensions in mm	CO1	PO2	**06**
		b			
	c)	A circular rod of diameter 50 mm is subjected to loads as shown in **Fig.1c**. Determine the nature and magnitude of stresses at critical points.	CO1	PO2	**08**
		OR			
2	a)	Define stress concentration and stress concentration factor. Discuss any 2 methods to minimize the effect of stress concentration with sketches.	CO1	PO1	**06**

		b)	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 is 210 GPa. Determine the permissible value of 'h' if the stress is limited to 130 N/mm^2.	*CO1*	*PO2*	**06**
		c)	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, 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.	*CO1*	*PO2*	**08**
			UNIT - II			
	3	a)	Derive the modified Soderberg's equation with usual notations.	*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)	Define the following terms: (i) Fluctuating stresses, (ii) Completely reversed stresses, (iii) Endurance limit.	*CO2*	*PO1*	**06**
		b)	A hot rolled steel shaft is subjected to a torsional moment that varies from 330 N-m (clockwise) to 110 N-m (counter clockwise) as an applied bending moment at the critical section varies from +440 Nm to – 220 Nm. The shaft is of uniform cross section and no keyway is present at the critical section. Determine the required shaft diameter. The material has an ultimate strength of 550 N/mm^2 and yield strength of 410 N/mm^2. Take the endurance limit as half the ultimate strength, factor of safety as 1.5, size factor of 0.85 and surface finish factor of 0.62.	*CO2*	*PO2*	**14**
			UNIT - III			
	5	a)	State the two approaches used in design of shafts.	*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	*CO3*	*PO3*	**18**

			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.			
			OR			
	6	a)	Design a socket and spigot type of cotter joint to connect two rods of 30C8 steel to carry an axial load of 100 kN. The allowable stresses are σ_t = 100 MPa; σ_c = 150 MPa and τ =60 MPa.	*CO3*	*PO3*	**10**
		b)	Design a Protected type cast iron flange coupling for a steel shaft transmitting 30 kW at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque to be transmitted is 20% 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 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. Take chain type riveting.	*CO3*	*PO3*	**10**
		b)	A plate of 80 mm wide and 15 mm thick is joined with another plate by a single transverse weld and a double parallel weld. Determine the length of parallel fillet weld if the joint is subjected to both static and fatigue loading. Take σ_t = 90 MPa and τ = 55 MPa as the allowable stresses. Take maximum tensile load as equal to the strength of plate.	*CO3*	*PO2*	**10**
			OR			
	8	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 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	*CO3*	*PO2*	**10**

			maximum stress does not exceed 50 N/mm^2. Consider the joint under static loading and then under dynamic loading.			
			UNIT - V			
	9	a)	Briefly explain the various types of stresses in threaded fasteners.	*CO3*	*PO1*	**06**
		b)	Two machine parts are fastened together by means of a M20 bolt. Neglecting the external load, find the stress induced in the bolt due to initial tightening.	*CO3*	*PO2*	**04**
		c)	A single start square threaded power screw is used to raise a load of 120 kN. The screw has 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*	**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 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*	**12**

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