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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

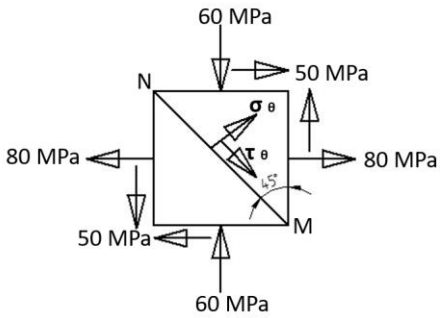
Programme: B.E. **Semester: IV**

Branch: Mechanical Engineering **Duration: 3 hrs.**

Course Code: 19ME4DCDM1 **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)	Define the following: (i) Factor of safety, (ii) Normal stress & (iii) Principal stresses.	*CO1*	*PO1*	**06**
	b)	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 using stress concentration factor when subjected to: (i) Bending moment of 200 Nm. (ii) Twisting moment of 400 Nm.	*CO1*	*PO2*	**06**
	c)	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.  **Fig. 1b**	*CO1*	*PO2*	**08**
		OR			
2	a)	Explain the following theories of failure: (i) Maximum normal stress theory and (ii) Maximum shear stress theory.	*CO1*	*PO1*	**06**
	b)	A rod of circular section is to sustain a torsional moment of 300 kN-m and bending moment 200 kN-m. Selecting 45C8 steel	*CO1*	*PO2*	**08**

			(σ_{yt} = 353 MPa) and assuming factor of safety = 3, determine the diameter of the rod as per the following theories of failure: (i) Maximum shear stress theory, & (ii) Distortion energy theory.			
		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 x 10^7 mm^4. Modulus of elasticity E=21 x 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 equation.	*CO2*	*PO1*	**06**
		b)	A circular bar of 500 mm length is supported freely at its two ends. It is acted centrally by a concentrated cyclic load having a minimum value of 20 kN and a maximum value of 50 kN. Determine the diameter of the bar by taking a factor of safety of 1.5, size factor of 0.85, surface finish factor of 0.9. The material properties of the bar are given by: ultimate strength of 650 MPa, yield strength of 500 MPa and endurance strength of 350 MPa.	*CO2*	*PO2*	**14**
			OR			
	4	a)	Derive the Goodman's relation for the members subjected to variable stresses.	*CO2*	*PO1*	**06**
		b)	A cold drawn steel rod of circular section is subjected to a variable bending moment of 565 Nm to 1130 Nm as the axial load varies from 4500 N to 13,500 N. The maximum bending moment occurs at the same instant as that of maximum axial load. Determine the required diameter of the rod for a factor of safety 2. Neglect stress concentration and column effect. Take σ_u as 550 MPa and σ_y as 470 MPa, endurance limit as 50 % of the ultimate strength and size, load and surface correction factors are 0.85,1.0 and 0.85 respectively.	*CO2*	*PO2*	**14**
			UNIT - III			
	5		A solid steel shaft running at 600 rpm is supported on bearings 600 mm apart. The shaft receives 40 kW through a 400 mm diameter pulley weighing 400 N located 300 mm to the right of left bearing by a vertical flat belt drive. The power is transmitted from the shaft through another pulley of diameter 600 mm weighing 600 N located 200 mm to the right of right bearing. The belt drives are at right angles to each other and ratio of belt tensions is 3. Determine the size of shaft necessary, if the allowable shear stress in the shaft material is 40 MPa and the loads are steady.	*CO3*	*PO3*	**20**

			OR			
	6	a)	Design a socket and spigot type of cotter joint to sustain an axial load of 100 kN. The material for the joint has an allowable tensile and compressive stress of 100 MPa and 150 MPa respectively. The allowable shear stress is 60 MPa.	*CO3*	*PO3*	**10**
		b)	Design a protected type flange coupling to transmit 30 kW at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted is to be 20% greater than the full load torque. The allowable shear stress in the bolt material is 60 MPa and 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 thick. 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 maximum stress does not exceed 50 N/mm^2. Consider the joint under static loading and then under dynamic loading.	*CO3*	*PO2*	**10**
			OR			
	8	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. Assume chain type of 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**
			UNIT - V			
	9	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**
			OR			
	10	a)	Explain the various types of stresses in threaded fasteners.	*CO3*	*PO2*	**08**
		b)	A machine slide weighing 20 kN is raised by a double start square threaded screw at the rate of 0.84 m/min. The coefficient of friction for screw and collar is 0.12 and 0.14 respectively. The major diameter of the screw is 44 mm and the pitch is 7 mm. The outside and inside diameter of the collar at the end of the screw are 58 mm and 32 mm respectively. Calculate the power required to drive the slide. If the allowable shear stress in the screw is 30 MPa, is the screw strong enough to sustain the load.	*CO3*	*PO2*	**12**

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