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

Autonomous Institute Affiliated to VTU

May / June 2025 Semester End Main Examinations

Programme: B.E. **Semester: VIII**

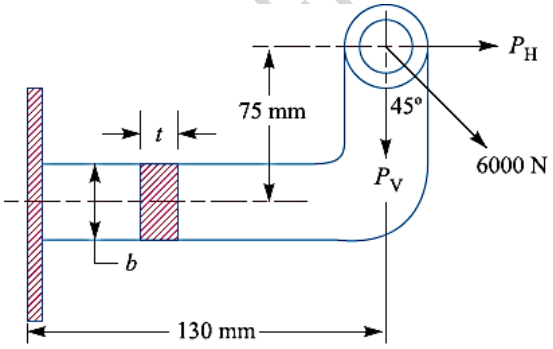
Branch: Aerospace Engineering **Duration: 3 hrs.**

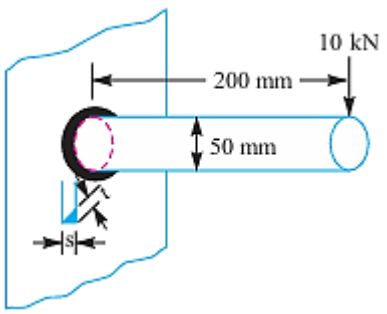
Course Code: 22AS8PEDME **Max Marks: 100**

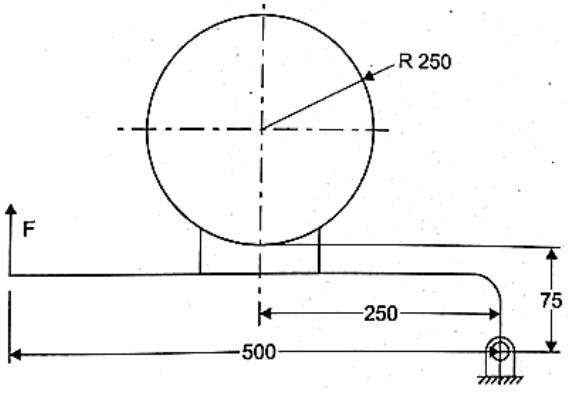
Course: Design of Machine Elements

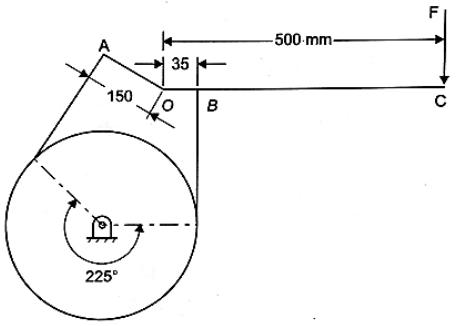
Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

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)		Discuss the general steps in machine design.	CO1	PO1	**8**
	b)		A mild steel bracket as shown in Fig. 1, 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. 1	CO1	PO3	**12**
			OR			
2	a)		Discuss the manufacturing considerations in design	CO1	PO1	**10**
	b)		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 1. the maximum principal stress; 2. the maximum shear stress; and 3. the maximum distortion strain energy theory of yielding.	CO1	PO1	**10**

			UNIT - II			
	3		A solid steel shaft is supported on two bearings 1.8 m apart and rotates at 250 r.p.m. 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. Design a suitable shaft taking working stress to be 42 MPa in shear and 84 MPa in tension.	CO3	PO3	**20**
			OR			
	4	a)	Design a close coiled helical compression spring for a service load ranging from 2250 N to 2750 N. The axial deflection of the spring for the load range is 6 mm. Assume a spring index of 5. The permissible shear stress intensity is 420 MPa and modulus of rigidity, G = 84 kN/mm^2. Neglect the effect of stress concentration. Draw a fully dimensioned sketch of the spring, show ing details of the finish of the end coils.	CO3	PO3	**10**
		b)	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 M Pa in shear. The allowable shear stress for CI flange is 8 M Pa. Design the bolts, hub and flange for the coupling	CO3	PO3	**10**
			UNIT - III			
	5	a)	A 50 mm diameter solid shaft is welded to a flat plate as shown in Fig. 2. If the size of the weld is 15 mm, find the maximum normal and shear stress in the weld.  Fig.2	CO3	PO3	**10**

		b)	Find the efficiency of the following riveted joints : 1. Single riveted lap joint of 6 mm plates with 20 mm diameter rivets having a pitch of 50 mm. 2. Double riveted lap joint of 6 mm plates with 20 mm diameter rivets having a pitch of 65 mm. Assume Permissible tensile stress in plate =120 MPa, Permissible shearing stress in rivets =90 MPa, Permissible crushing stress in rivets =180 MPa	CO3	PO3	**10**
			OR			
	6	a)	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 M Pa, σ_c = 150 M Pa and τ = 60 M Pa.	CO3	PO3	**10**
		b)	Design a knuckle joint to transmit 150 kN. The design stresses may be taken as 75 MPa in tension, 60 MPa in shear and 150 MPa in compression.	CO 3	PO3	**10**
			UNIT - IV			
	7	a)	Deduce an expression for frictional torque based on uniform pressure and uniform wear assumption for a plate or disc clutch.	CO2	PO1	**10**
		b)	Design a single plate clutch having both sides effective from the following data: Power transmitted = 30 kW, speed of shaft= 1500 rpm, allowable lining pressure = 0.147 MPa, maximum diameter of the clutch = 300 mm, service factor = 1.5, number of springs = 9, compression of spring during engagement = 2.5 mm.	CO2	PO3	**10**
			OR			
	8	a)	A block brake of drum radius 250 mm contacts a single shoe as shown in Fig. 3 and sustains a torque of 200 N-m at 750 rpm. For u = 0.25, determine: a). Normal force on the shoe. B). Operating force for clockwise rotation of drum c). Operating force for counterclockwise rotation of drum.d). Heat generated. e). What value of c would make the brake self locking?  Fig. 3 All dimensions are in mm.	CO2	PO2	**10**

		b)	A differential band brake as shown in Fig. 4 has an angle of contact of 225°, The band has a compressed woven lining and bears against a cast iron drum of 350 mm diameter. The brake is to sustain a torque of 350 N-m and the coefficient of friction between the band and the drum is 0.3. Find: a) The necessary force, F for clockwise rotation and anticlockwise rotation of the drum. b) The value of OA for the brake to be self-locking, when the drum rotates clockwise.  Fig. 4 All dimensions are in mm.	CO2	PO2	**10**
			UNIT - V			
	9	a)	A pair of straight teeth spur gears, having 20° involute full depth teeth is to transmit 10 kW at 300 rpm of the pinion. The speed ratio is 3:1. The allowable static stress for gear of cast iron and pinion of steel are 60 MPa and 105 MPa respectively. Assume the following: Number of teeth on pinion = 16; Face width = 12-time module Velocity factor Cv = $\frac{4.5}{4.5+v}$ v being the pitch line velocity in m/s Tooth form factor y = $0.154 + \frac{0.912}{z}$ Determine the module, face width and pitch diameter of the gears. Check the gear for wear, given σ_{es}, = 600 MPa., E_p = 200 kN/mm² and E_G = 100 kN/mm^2.	CO3	PO3	**14**
		b)	Obtain an expression for formative number of teeth in helical gear.	CO3	PO1	**6**
			OR			
	10	a)	Discuss the formation of continuous oil film in a journal bearing with relevant sketches	CO4	PO1	**8**
		b)	Following specifications refer to idealized full journal bearing: Diameter of journal = 50 mm, speed of journal =1200 rpm, diametral clearance = 0.06 mm, length of journal = 65 mm, Attitude = 0.8, absolute viscosity = 11 cP, Lubrication and Determine: a) Minimum film thickness b) Sommerfeld number c) Load carrying capacity d) Coefficient of friction e) Power loss f) Frictional force	CO4	PO2	**12**

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