U.S.N.										

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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

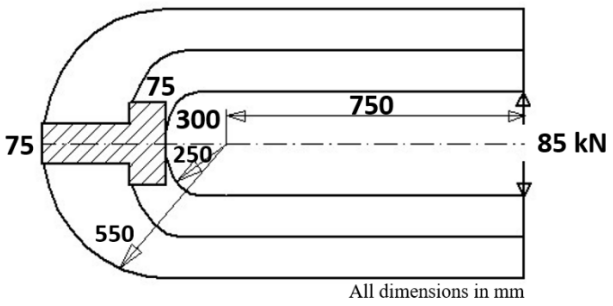
Programme: B.E. **Semester: V**

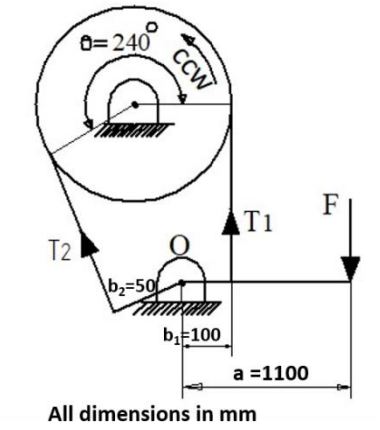
Branch: Mechanical Engineering **Duration: 3 hrs.**

Course Code: 23ME5PCDM2 / 22ME5PCDM2 **Max Marks: 100**

Course: Design of Machine Elements - 2

Instructions: 1. Answer any Five full questions choosing one from each unit.
2. Use of design data handbook is permitted.
3. Any missing data may be suitably assumed.

		UNIT - I	*CO*	*PO*	Marks
1	a)	State the assumptions and derive the stress equation in case of a curved beam using standard notations.	*CO1*	*PO1*	**08**
	b)	A loaded narrow gauge car weighs 18 kN and moving at a velocity of 80 m/min is brought to rest by a buffer consisting of 2 helical springs. In bringing the car to rest the spring undergoes a compression of 200 mm. The allowable shear stress is 0.3 GPa and the spring index is 8. Design a suitable spring taking modulus of rigidity as 84 GPa.	*CO1*	*PO2*	**12**
		OR			
2	a)	Develop an expression for maximum shear stress induced in the wire of a helical compression spring subjected to an axial compressive force.	*CO1*	*PO1*	**08**
	b)	Determine the combined stresses at the inner and outer fiber and also the maximum shear stress in the frame of the punching machine shown in Fig. 2(b), if it has to resist a force of 85 kN.  Fig. 2(b)	*CO1*	*PO2*	**12**

			UNIT - II			
	3	a)	Derive an expression for torque transmitted by a single plate clutch considering uniform wear condition on the clutch with usual notations.	*CO2*	*PO1*	**10**
		b)	A simple band brake of drum diameter 600 mm has a band passing over it with an angle of contact of 225^0, while one end is connected to the fulcrum, the other end is connected to the brake lever at a distance of 400 mm from the fulcrum. The brake lever is 1 m long. The brake is to absorb a power of 15 kW at 720 rpm. Design the brake lever of rectangular cross-section, assuming depth to be thrice the width. Take allowable stress as 80 MPa.	*CO2*	*PO2*	**10**
			OR			
	4	a)	A car engine develops maximum power of 15 kW at 1000 rpm. The clutch used is single plate type of both sides effective having external diameter 1.25 times the internal diameter and coefficient of friction is 0.3. Mean axial pressure is not to exceed 0.085 N/mm^2. Determine the dimensions of the friction surface and the force necessary to engage the plates. Assume uniform pressure condition.	*CO2*	*PO2*	**10**
		b)	A differential band brake shown in Fig. 4b operates on a drum diameter of 500mm. The drum rotates at 300 rpm in counter clockwise direction and absorbs 36 kW. Coefficient of friction is 0.25. Determine: (i) Force F required to operate the brake,(ii) Width of band required for this brake if thickness is 5 mm and allowable tensile stress on band material is 72 N/mm^2, (iii) Design the lever if the maximum force is twice that of calculated force. Use C30 steel and FOS = 4 based on ultimate stress of 540 MPa. Assume rectangular cross-section for the lever with depth equal to thrice the width.  Fig. 4b	*CO2*	*PO2*	**10**

			UNIT - III			
	5	a)	Derive an expression for virtual number of teeth of a helical gear using standard notations.	*CO3*	*PO1*	**04**
		b)	A pair of carefully cut spur gears with 20^0 full depth involute profile is used to transmit 12 kW at 1200 rpm of pinion. The gear has to rotate at 300 rpm. The material used for both pinion and gear is medium carbon steel whose allowable bending stress may be taken as 230 MPa. Determine the module and face width of the spur pinion and gear. Suggest suitable hardness. Take 24 teeth on pinion and service factor C_s as 1.5. Modulus of elasticity may be taken as 210 GPa.	*CO3*	*PO3*	**16**
			OR			
	6	a)	Derive an expression for formative number of teeth in a bevel gear.	*CO3*	*PO1*	**04**
		b)	Design a pair of bevel gears to connect two shafts at 60^0. The gears are made of alloy steel case hardened (σ_0 = 345 MPa) and precision cut with form cutters. The gear ratio is 5:1. The power transmitted is 30 kW at 900 rpm of the pinion. The teeth are 20^0 full depth. The pinion has 24 teeth. Suggest suitable surface hardness for the gear pair. Take service factor C_s as 1.5.	*CO3*	*PO3*	**16**
			UNIT - IV			
	7	a)	Stating the assumptions, derive Petroff's equation for estimating the coefficient of friction in a journal bearing.	*CO4*	*PO1*	**08**
		b)	A full journal bearing having diameter of 50 mm and 100 mm long has a bearing pressure of 1.2 N/mm^2. The speed of the journal is 1000 rpm. The bearing is lubricated at 75^0 C (bearing surface temperature) having viscosity of 0.011 Pas. The room temperature is 35^0 C. Take the minimum film thickness as 1/4 of diametral clearance. The specific heat of oil is 1850 J/kg^0 C and the weight per unit volume of oil is 8.83 kN/m^3. The ratio of journal diameter to diametral clearance is 1000. Calculate : (i) Load which can be supported by bearing, (ii) Power lost due to friction, (iii) Attitude of bearing and eccentricity & (iv) The amount of artificial cooling required.	*CO4*	*PO3*	**12**
			OR			
	8	a)	Discuss (i) Bearing characteristic number and bearing modulus & (ii) Sommerfeld number with respect to journal bearing.	*CO4*	*PO1*	**08**
		b)	A hydrodynamic journal bearing of diameter 75 mm and length 75 mm is lubricated using SAE 20 oil. The oil enters at 40^0 C and the journal rotates at 1200 rpm. The diametral clearance is 0.075 mm. Assume operating temperature of the oil as 53^0 C.	*CO4*	*PO3*	**12**

			Determine: (i) magnitude and location of the minimum film thickness, (ii) power loss (iii) oil flow through the bearing with side leakage.			
			UNIT - V			
	9	a)	Two shafts 1 meter apart are connected by a V-belt to transmit 90 kW at 1200 rpm of a driver pulley of 300 mm effective diameter. The driven pulley rotates at 400 rpm. The angle of groove is 40^0 and the coefficient of friction between the belt and the pulley rim is 0.25. The area of the belt section is 400 mm^2 and the permissible stress is 2.1 MPa. Density of belt material is 1100 kg/m^3. Calculate the number of belts required and the length of the belt.	*CO5*	*PO2*	**10**
		b)	Select a chain drive to activate a compressor from 10 kW electric motor at 970 rpm, the compressor rpm being 350. Minimum center distance should be approximately 560 mm. The chain tension may be adjusted by shifting the motor on rails. The compressor is to work for 10 hours per day.	*CO5*	*PO2*	**10**
			OR			
	10	a)	Select a V - belt drive to transmit 10 kW of power from a pulley of 200 mm pitch diameter mounted on an electric motor running at 720 rpm to another pulley mounted on compressor running at 200 rpm. The service is heavy duty varying from 10 hours to 14 hours per day and center distance between center of pulleys is 600 mm.	*CO5*	*PO2*	**10**
		b)	Select a wire rope for a vertical mine hoist to lift a load of 55 kN from a depth of 300 m. A rope speed of 500 m/min is to be attained in 10 seconds.	*CO5*	*PO2*	**10**

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