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

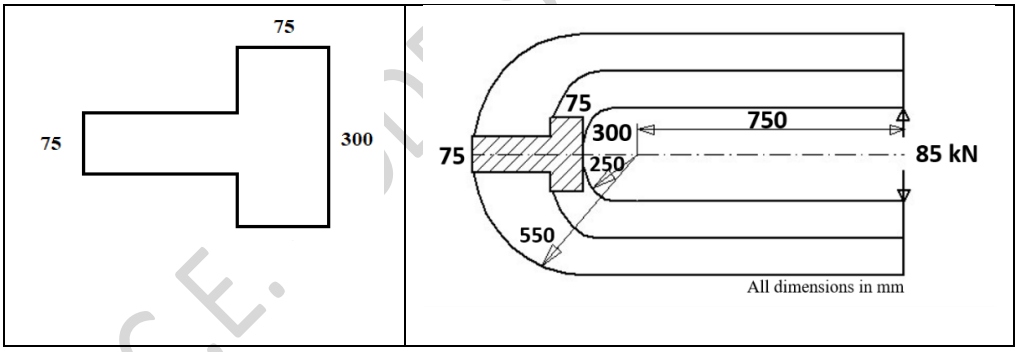
Autonomous Institute Affiliated to VTU

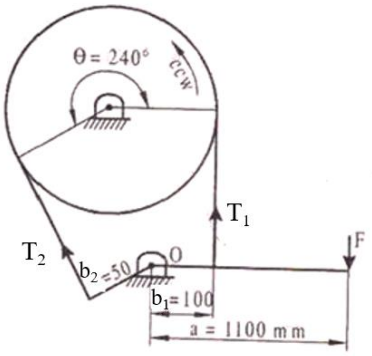
January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 20ME5DCDM2/16ME5DCDM2 **Max Marks: 100**
Course: Design of Machine Elements - 2

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may suitably be assumed.
3. Use of design data hand book is permitted.
4. Use of calculator 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	
1	a)		State the assumptions and derive the stress equation in case of a curved beam.	**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. 1(b), if it has to resist a force of 85 kN.  Fig. 1(b)	**12**
			OR	
2	a)		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.	**12**
	b)		Design a leaf spring for the following specifications for a truck. Total load = 120 kN. Number of springs = 4. Material for the spring is Chrome-Vanadium steel. Permissible stress is 0.55 GPa. Span of spring = 1100 mm. Width of central band = 100 mm and allowable deflection = 80 mm. Number of full length leaves are 2 and graduated leaves are 6. Take E = 206.9 GPa.	**08**
			UNIT - II	
3	a)		With usual notations derive an expression for torque transmitted by a single plate clutch considering uniform wear condition on the clutch.	**06**

		b)	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.	**06**
		c)	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.	**08**
			OR	
	4	a)	Derive an expression for torque transmitted by a single plate clutch considering uniform pressure condition on the clutch.	**06**
		b)	A 25 kW at 3000 rpm is to be transmitted by a multiple friction clutch. The plates have friction surfaces of steel and phosphor bronze and run in oil. Design the clutch for 25 % overload. Assume C30 steel (σ_y = 294.2 MPa & τ = 49.03 MPa) for shaft and factor of safety of 3.	**06**
		c)	A differential band brake shown in **Fig. 4c** 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 and (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 depth equal to thrice the width.  **Fig. 4c** (All dimensions in mm)	**08**
			UNIT - III	
	5	a)	Derive an expression for beam strength of a spur gear tooth using standard notations.	**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	**16**

			teeth on pinion and service factor C_s as 1.5. Modulus of elasticity may be taken as 210 GPa.	
			OR	
	6	a)	Derive an expression for formative number of teeth in a bevel gear.	**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.	**16**
			UNIT - IV	
	7	a)	Stating the assumptions, derive Petroff's equation for estimating the coefficient of friction in a journal bearing.	**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. Determine: (i) magnitude and location of the minimum film thickness, (ii) power loss and (iii) oil flow through the bearing with side leakage.	**12**
			OR	
	8	a)	Determine the power loss from a Petroff's bearing with its journal length and diameter as 150 mm and 100 mm respectively. The speed of the journal is 1000 rpm, and the diametral clearance is 0.1 mm. The lubricating oil is SAE 10 and the bearing operates at a temperature of 60^0 C.	**08**
		b)	Define the following bearing parameters: (i) Eccentricity, (ii) Short and Long bearing, (iii) Diametral clearance ratio, (iv) Attitude, (v) Diametral clearance and (vi) Minimum oil film thickness. Write an appropriate expression for the above parameters.	**12**
			UNIT - V	
	9	a)	Select a V - belt drive to connect a 15 kW, 2880 rpm motor to a centrifugal pump, running at approximately 2400 rpm, for a service of 18 hours per day. The center distance should be approximately 400 mm. Assume the pitch diameter of driving pulley as 125 mm.	**10**
		b)	A 20 mm, 8 x 19 steel wire rope is used with a hoisting drum of 1 m diameter to lift a load of 20 kN. The depth of the mine is 800 m and the acceleration is 3 m/s^2. Determine the number of ropes required using a factor of safety 5. Neglect the weight of skip. Take modulus of elasticity of rope as 82728 MPa.	**10**
			OR	
	10	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.	**10**
		b)	Select a chain drive to activate a compressor from 10 kW electric motor at 970	**10**

			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.	

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