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Course Code

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Sixth Semester B.E. Degree Examinations, May/June 2025

DESIGN OF MACHINE ELEMENTS-II

Duration: 3 hrs

Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of Design Data Handbook is permitted.
3. Missing data, if any, may be suitably assumed.

<u>Q. No</u>	<u>Question</u>	<u>Marks</u>	<u>(RBTl:CO: PI)</u>
<u>Module-1</u>			
1.	a. The horizontal cross-section of a crane hook is an isosceles triangle of 120 mm deep, the inner width being 90 mm. The hook carries a load of 50 kN. Determine the stress at the extreme fibres.	10	(3 :1: 1.4.1)
	b. Determine the maximum stress induced in a ring cross-section of a 50 mm diameter rod subjected to a compressive load of 20 kN. The mean diameter of the ring is 100 mm.	10	(3 :1: 1.4.1)
(OR)			
2.	a. Design a helical compression spring for a maximum load of 1000 N and a deflection of 25 mm. The maximum permissible shear stress for the material of the wire is 420 N/mm ² and the modulus of rigidity is 84 GPa.	10	(4 :1: 1.4.1)
	b. A multi-leaf spring with camber is fitted to the chassis of an automobile over a span of 1.2 m to absorb shocks due to a maximum load of 20 kN. The spring material can sustain a maximum stress of 0.4 GPa. All the leaves of the spring were to receive the same stress. The spring should have at least 2 full-length leaves out of 8 leaves. The leaves are assembled with bolts over a span of 150 mm width at the middle. Design the spring for a maximum deflection of 50 mm.	10	(4 :1: 1.4.1)
<u>Module-2</u>			
3.	Design a spur gear drive to transmit 55 kW at 800 rpm of the pinion. The speed ratio is to be 3.2: 1. The teeth are to be 20° FDI. (Assume both pinion and gear are made of same material, $\sigma_d = 193.2$ MPa)	20	(4 :2: 1.4.1)
(OR)			
4.	a. Derive the expression for the formative (virtual) number of teeth for Helical gears with the help of a neat sketch.	08	(4 :2: 1.4.1)
	b. Design a pair of equal-diameter 20° stub teeth helical gears to transmit 37.5 kw with moderate shocks at 1200 rpm. The two shafts are parallel and 0.45 m apart. Each gear is made of steel with $\beta = 30^\circ$.	12	(4 :2: 1.4.1)
<u>Module-3</u>			
5.	a. Derive the expression for the formative (virtual) number of teeth of bevel gears with the help of a neat sketch.	08	(4 :3: 1.4.1)

Note: (RBTl - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI- Performance Indicator)

- b. Design a pair of bevel gears to connect two shafts at 60° . The power transmitted is 25 kW at 900 rpm of a pinion. The reduction ratio is 5:1. The teeth are 20° FDI, and the pinion has 24 teeth. Check the design for dynamic consideration. 12 (4 :3: 1.4.1)

(OR)

6. Design a worm drive for a speed reduction to transmit 30 kW at a worm speed of 600 rpm. The required velocity ratio is 25:1. The worm is made of C30 heat-treated steel (220.6 MPa), and the worm wheel is made of phosphor bronze (82.4 MPa). The service conditions are intermittent operations with medium shock loads. Also, calculate the heat dissipation through the drive. 20 (4 :3: 1.4.1)

Module-4

7. a. Design a cone clutch to transmit 40 kW at 750 rpm. Also, determine the
(i) Axial force required to transmit the torque
(ii) Axial force required to engage the clutch.
Assume $f = 0.4$ and $p = 0.2 \text{ N/mm}^2$ for the friction material ($\alpha = 12.5^\circ$)
Take $D_m/b = 6$. 10 (4 :4: 1.4.1)

- b. A soft surface one clutch has an inclined angle of 20° , the mean diameter of the cone is 300 mm, the face width is 100 mm, the expected coefficient of friction is 0.2, and the average (mean) pressure is limited to 70 kPa. Calculate the following. 10 (3 :4: 1.4.1)
- (i) Minimum and Maximum diameter of the cone
(ii) Axial force required to transmit the torque.
(iii) Power that can be transmitted at 710 r/min
(iv) Axial force needed to engage the clutch

(OR)

8. a. As shown in Figure 8 (a), a band brake uses a V-belt. The pitch diameter of the V-grooved sheave is 500 mm. The groove angle is 45° and the coefficient of friction is 0.25. Determine the power rating at 300 rev/min. 10 (3 :4: 1.4.1)

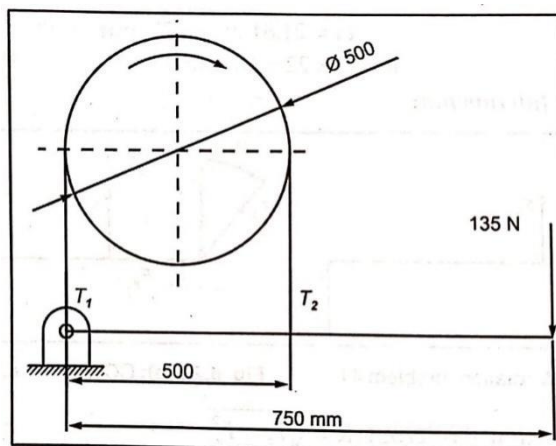


Figure 8(a)

- b. A spring-closed thruster-operated double-shoe brake is to be designed for a maximum torque capacity of 3000 N-m. The brake drum diameter is not to exceed 1m, and the shoes are to be lined with Ferodo, having a coefficient of friction of 0.3. The rest of the dimensions are shown in Figure 8(b). 10 (3 :4: 1.4.1)

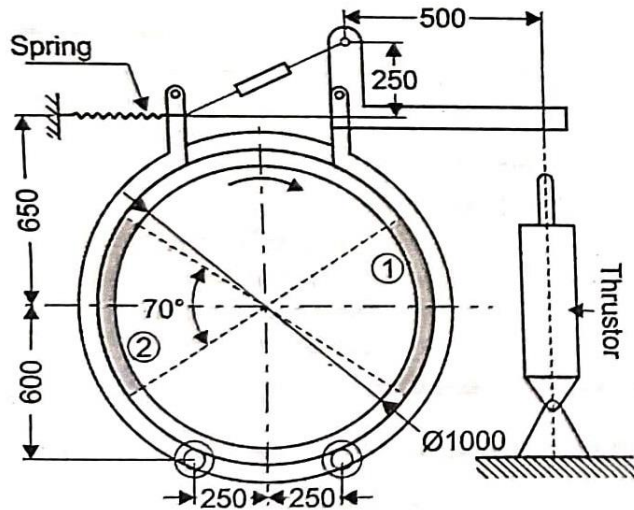


Figure 8(b)

- (i) Find the spring force necessary to set the brake.
- (ii) Find the width of the brakes if the bearing pressure on the lining material is not to exceed 0.5 N/mm^2 .
- (iii) Calculate the force required to be exerted by the thrustor to release the brake.

Module-5

9. a. Derive Petroff's equation for frictional power loss for a lightly loaded journal bearing rotating at high speed concentric to the bearing. 10 (4 :5: 1.4.1)
 - b. A 75 mm long full journal bearing of diameter 75 mm supports a radial load of 12 kN at a shaft speed of 1800 rpm. Assume ratio of diameter to the diametral clearance as 1000. The viscosity of oil is 0.01 Pa-s at the operating bearing temperature. Determine 10 (3 :5: 1.4.1)
 - (i) Coefficient of friction based on McKee's Equation
 - (ii) The probable temperature of the bearing, assuming that the heat generated is dissipated in still air at 20°C using McKee's equation.
- (OR)
10. a. A deep groove ball bearing of BC02 series has to work under the following work cycle at a constant speed of 1440 r/min 10 (3 :5: 1.4.1)
 - (i) Radial load of 2.5 kN for 10 seconds
 - (ii) Radial load of 1.2 kN for 20 seconds
 - (iii) Radial load of 450 N for 30 seconds

And the above cycle repeats itself. The bearing has to work for 5 years at 80 hours per week. Select the bearing for the above purpose.
 - b. A ball bearing is operating on a work cycle consisting of three parts, 10 (3 :5: 1.4.1)

namely: Radial load of 2500 N at 1420 rpm for one quarter cycle, radial load of 1000 N at 710 rpm for one half cycle, radial load of 5000 N at 1420 rpm for the remaining cycle. The expected bearing life is 10000 hrs. Calculate the dynamic load capacity of the bearing.

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