



**K. K. Wagh Institute of Engineering Education & Research, Nashik**  
(An Autonomous Institute From A.Y. 2022-23)

SUMMER-2024	
Exam Seat No.:	
Academic Year:2023-2024	Semester:IV
Class: SY	Program: B.Tech
Branch Code: ROB	Pattern:2022
Name of Course: Design of Machine Elements	Course Code: ROB222012
Max. Marks:60	Duration:2.30 Hrs.

**Instructions:** Candidates should read carefully the instructions printed on the Question Paper and on the cover page of the Answer Book, which is provided for their use.

1. This question paper contains 3 pages.
2. Answer to each new question is to be started on a new page.
3. Assume suitable data wherever required, but justify it.
4. Draw the neat labelled diagrams, wherever necessary.
5. The last columns indicates the Course Outcome and level of Blooms Taxonomy of the Question/sub-question.

**Question No. 1 Attempt following Question**

- 1a) What is Modulus of Elasticity? (6) CO1, CO2  
A steel rod with a circular cross-section is subjected to a bending moment of 2500 Nm. The radius of the rod is 0.25 m. Calculate the moment of inertia of the circular cross-section, and determine the maximum bending stress in the rod. Assume the rod is made of steel with a modulus of elasticity E of 200 GPa.

**Question No. 2 Attempt following Question**

- 2a) What is slip and creep of a belt? (6) CO3, CO4  
Following data is given for a rope pulley transmitting 20 kW.  
Diameter of pulley = 410 mm; Speed = 120 rpm.; angle of groove = 45°; Angle of lap on smaller pulley = 160°; Coefficient of friction = 0.30; Number of ropes = 12. Find tensions on both sides of the rope.

**Question No. 3 Attempt following Question**

- 3a) Explain the classification of gears in detail. (8) CO1, CO5

**OR**

- 3b) What is the difference between simple gear train and compound gear train? (8) CO1, CO5  
A compound train consists of six gears. The number of teeth on the gears are as follows:

Gear	A	B	C	D	E	F
No. of Tooth	70	50	60	30	36	30

The gears B and C are on one shaft while the gears D and E are on another shaft. The gear A drives

rotates at 950 r.p.m.  
What is the speed of gear F?

- 3c) Define circular pitch, diametral pitch and module with respect to gears. (8) CO1, CO5  
Determine the minimum number of teeth required on a pinion, in order to avoid interference which is to gear with,  
1. a wheel to give a gear ratio of 4 to 1; and 2. a wheel to give a gear ratio of 5:1.  
The pressure angle is  $20^\circ$  and a standard addendum of 1 module for the wheel may be assumed.

**OR**

- 3d) What is the difference between reverted gear train and epicyclic gear train? (8) CO1, CO5  
The speed ratio of the reverted gear train is to be 18. The module pitch of gears A and B is 3.525 mm and of gears C and D is 2.75 mm. Calculate the suitable numbers of teeth for the gears. The distance between centers of the shaft of gears A and B, and gears C and D is same and is equal to 250 mm.

**Question No. 4 Attempt following Question**

- 4a) What is a shaft? What are its key characteristics? Give its detail classification based on geometry. (8) CO1

**OR**

- 4b) Explain the concept of shafts subjected to the combination of twisting moment and bending moment. (8) CO1  
A solid circular shaft is subjected to a bending moment of 3500 Nm and a torque of 12000 Nm. The shaft is having ultimate tensile stress of 750 MPa and an ultimate shear stress of 550 MPa. Assuming a factor of safety of 5, determine the diameter of the shaft.

- 4c) What is a bearing? What are the types of rolling contact bearings? Explain the basics of hydrodynamic theory of lubrication. (8) CO1

**OR**

- 4d) i) A hollow shaft of external and internal diameter of 100 mm and 70 mm is required to transmit torque from one end to other. What is the safe torque it can transmit, if the allowable shear stress is 50 MPa. (4 Marks) (8) CO1  
ii) A solid cylindrical steel shaft with a diameter of  $D = 80\text{ mm}$  and a length  $L = 1\text{ m}$  is subjected to a bending moment  $M = 1200\text{ Nm}$ . The material properties of the steel shaft are:  
Young's Modulus (E): 200 GPa, Poisson's Ratio ( $\nu$ ): 0.3  
Determine the maximum bending stress experienced by the shaft. (4 Marks)

**Question No. 5 Attempt following Question**

- 5a) Explain in detail about the types of screw thread used for power screws. (8) CO1

**OR**

- 5b) A vertical screw with single start square threads of 60 mm mean diameter and 12.5 mm pitch is raised against a load of 12 kN by means of a hand wheel, the boss of which is threaded to act as a nut. The axial load is taken up by a thrust collar which supports the wheel boss and has a mean diameter of 70 mm. The coefficient of friction is 0.15 for the screw and 0.18 for the collar. If the tangential force applied by each hand to the wheel is 150 N, find suitable diameter of the hand wheel. (8) CO1

- 5c) Explain the concept of over-hauling and self-locking screws, and write the expression for the efficiency of the self-locking screw. Also explain the concept of Acme threads. (8) CO1

**OR**

- 5d) The lead screw of a lathe has Acme threads of 70 mm outside diameter and 8 mm pitch. The screw (8) CO1

collar 120 mm outside diameter and 60 mm inside diameter and the lead screw rotates at 50 r.p.m.  
Determine (a) the power required to drive the screw; and (b) the efficiency of the lead screw.  
Assume a coefficient of friction of 0.15 for the screw and 0.12 for the collar.

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