

DEPARTMENT OF MECHATRONICS

IV SEMESTER B.TECH. (MECHATRONICS) END SEMESTER EXAMINATION

SUBJECT: Design of Machine Elements

Time: 3 Hrs

Date: 26/05/2023

Subject Code: MTE 2252 MAX. MARKS: 50

- ✤ Answer ALL the questions.
- ✤ Assume suitable data that is not provided.
- ✤ Use of design data hand book is permitted.

Q. No.	Questions	Μ	CO	PO	LO	BL
1A	The lead screw of a lathe has single-start ISO metric trapezoidal threads of 52 mm nominal diameter and 8 mm pitch. The screw is required to exert an axial force of 2 kN in order to drive the tool carriage during turning operation. The thrust is carried on a collar of 100 mm outer diameter and 60 mm inner diameter. The values of coefficient of friction at the screw threads and the collar are 0.15 and 0.12 respectively. The lead screw rotates at 30 rpm. Evaluate the power required to drive the lead screw.	5	3	1,3	1,2	5
1B	A machine vice, as shown in Figure 1B , has single-start, square threads with 22 mm nominal diameter and 5 mm pitch. The outer and inner diameters of the friction collar are 55 and 45 mm respectively. The coefficients of friction for thread and collar are 0.15 and 0.17 respectively. The machinist can comfortably exert a force of 125 N on the handle at a mean radius of 150 mm. Assuming uniform wear for the collar, determine the clamping force developed between the jaws.	3	3	1,3	1,2	5
1C	The nominal diameter of a triple threaded square screw is 50 mm. While the pitch is 8 mm. It is used with a collar having $Di = 65$ mm $D_0 = 100$ mm. The coefficient of friction at the thread surface as well as at the collar surface may be taken as 0.15. The screw is used to lift a load of 15 kN. Using uniform wear theory for collar friction determine, (i) Torque required to raise the load (ii) Torque required to lower the load.	2	3	1,3	1,2	5

ANIPAL INSTITUTE OF TECHNOLOGY constituent unit of MAHE, Manipal) 2A A wall bracket with a rectangular cross-section is shown in **Figure** 2 4 1,3 1,2 5 2A. The depth of the cross-section is twice of the width. The force P acting on the bracket at 60° to the vertical is 5 kN. The material of the bracket is grey cast iron FG 200 and the factor of safety is 3.5. Determine the dimensions of the cross-section of the bracket. Assume maximum normal stress theory of failure. 300 60 150 **Figure 2A 2B** A flat plate subjected to a tensile force of 5 kN is shown **Figure 2B**. 5 3 2 1.3 1,2 The plate material is grey cast iron FG 200 and the factor of safety is 2.5. Determine the thickness of the plate. 5R15 0 45 30 5 kN Figure 2B **2**C 2 A cantilever beam of rectangular cross-section is used to support a 31.3 1.2 4 pulley as shown in Figure 2C. The tension in the wire rope is 5 kN. The beam is made of cast iron FG 200 and the factor of safety is 2.5. The ratio of depth to width of the cross-section is 2. Determine the dimensions of the cross-section of the beam. 1500 + 500-500 5 kN **Figure 2C**

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3A	A single-row deep groove ball bearing is subjected to a pure radial force of 3 kN from a shaft that rotates at 600 rpm. The expected life (Lh) of the bearing is 30000 h. The minimum acceptable diameter of the shaft is 40 mm. Select a suitable ball bearing for this application.	4	4	1,3	1,2	3
38	A single-row deep groove ball bearing No. 6202 is subjected to an axial thrust of 1000 N and a radial load of 2200 N. Evaluate the expected life that 50% of the bearings will complete under this condition.	4	4	1,3	1,2	5
3C	A cantilever of length 3 m is carrying a point load of 50 kN at a distance of 2 m from the fixed end. If $I = 10^8$ and $E = 2 \times 10^5 \text{ N/mm}^2$, determine (i) slope at the free end and (ii) deflection at the free end.	2	1	1,3	1,2	5
4A	When a coil spring scale of 18 kN/m is compressed 30 mm, the coils are closed. The material of spring is high carbon wire with Mn grade, the spring index, C=8, the ends are squared and ground and G= 83 Gpa. Determine the closed length of the spring.	5	3	1,3	1,2	5
4B	When a coil subjected to a force of 10 kN is compressed, the coils are closed. The spring is made by high carbon wire with Mn grade. Take a FOS of 3.0. The spring index is 8, the ends are squared and ground, and G=83 GPa. Determine the required wire diameter of spring.	3	3	1,3	1,2	5
4C	A cantilever of length 2 m fails when a load of 2 kN is applied at the free end as shown in Figure 4C . If the section of the beam is 40 mm X 60 mm, determine the stress at the failure.	2	1	1,3	1,2	5
5A	It is required to design a pair of spur gears with 20° full-depth involute teeth consisting of a 20-teeth pinion meshing with a 50 teeth gear. The pinion shaft is connected to a 22.5 kW, 1450 rpm electric motor. The starting torque of the motor can be taken as 150% of the rated torque. The material for the pinion is plain carbon steel Fe 410 $(S_{ut} = 410 \text{N/mm}^2)$, while the gear is made of grey cast iron FG 200 $(S_ut=200 \text{N/mm}^2)$. The factor of safety is 1.5. Design the gears based on the Lewis equation and using velocity factor to account for the dynamic load.	4	4	1,3	1,2	6

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5B	The layout of an intermediate shaft of a gear box supporting two spur gears B and C is shown in Figure 5B . The shaft is mounted on two bearings A and D. The pitch circle diameters of gears B and C are 900 and 600 mm respectively. The material of the shaft is steel FeE 580 (Sut = 770 and Syt = 580 N/mm ²). The factors k_b and k_t of ASME code are 1.5 and 2.0 respectively. Determine the shaft diameter using the ASME code. Assume that the gears are connected to the shaft by means of keys.	3	5	1,3	1,2	5
5C	A hollow steel tube 3.5m long has external diameter of 120 mm as shown in Figure 5C . In order to determine the internal diameter, the tube was subjected to a tensile load of 400 kN and extension was measured to be 2 mm.If the modulus of elasticity for the tube material is 200 GPa, determine the internal diameter of the tube.	3	1	1,3	1,2	5