MANIPAL INSTITUTE OF TECHNOLOGY
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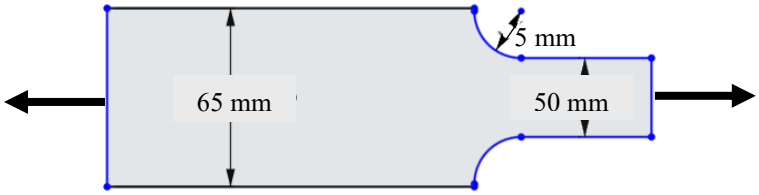
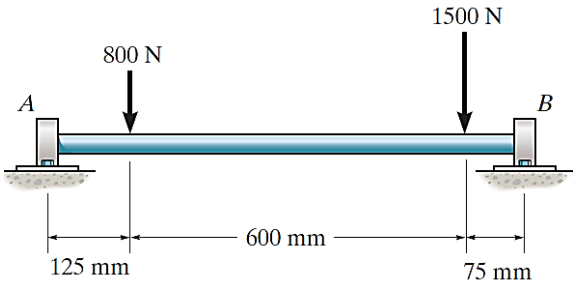
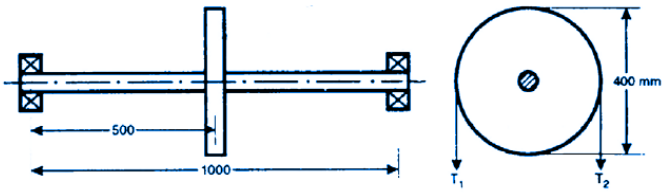
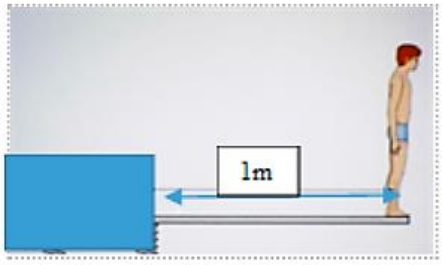
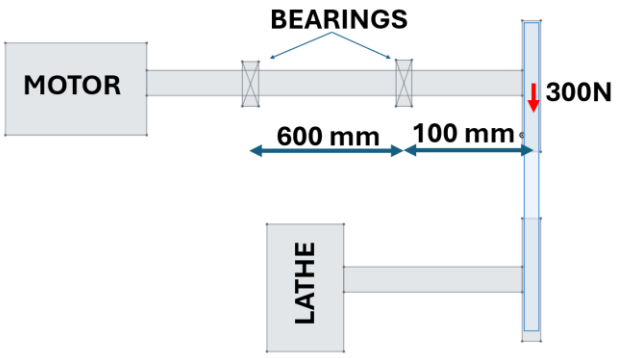
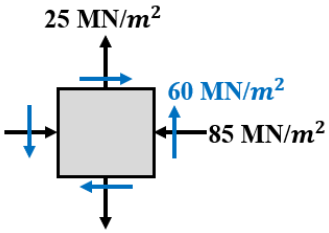
DEPARTMENT OF MECHATRONICS
IV SEMESTER B.TECH. MECHATRONICS
END SEMESTER EXAMINATION, JULY 2024
SUBJECT: Design of Machine Elements **Subject Code: MTE 2222**
Time: 180 Mins **Exam time: 2:30 pm – 5:30 pm** **MAX. MARKS: 50**

- Answer **ALL** questions.
- Missing data if any, maybe suitably assumed.

Q. No.		M	CO	PO	LO	BL
1A.	A hot rolled steel bar is subjected to a tensile force that varies from 30 kN to 10 kN. The material of the bar has an ultimate strength of 600 N/mm^2 and a yield strength of 400 N/mm^2. Estimate the diameter of the bar for continuous operation using a factor of safety 2. Use the Soderberg design equation.	5	2	1,3	1,2	3
1B.	A stepped shaft, as shown in Fig Q1B, is subjected to an axial tensile load of 48 kN. Determine the theoretical stress concentration and, hence, the maximum stress in the member.  Fig Q1B	3	2	1,3	1,2	3
1C.	An SKF6315 bearing is used to support a shaft running at 300 RPM. If the bearing is subjected to a pure radial load of 26000N, calculate the expected life of the bearing in number of hours.	2	4	1,3	1,2	3
2A.	In a beam shown in Fig Q 2A, estimate the deflection at load points. The material has a Young's modulus of 200 GN/m^2. The diameter of the shaft is 20 mm.  Fig Q2A	5	1	1,3	1,2	3

2B.	A shaft is placed between 2 bearings 1000 mm apart as shown in Fig Q2B. A pulley weighing 6000N is placed at the center of the shaft. The pulley transmits power to another pulley exactly below it. The tension on the tight side of the pulley is 1000N and tension on slack side is 500N. If the allowable shear stress is 50 MN/m^2, calculate the diameter of the shaft. Take C_m = C_t=1.5. Use maximum shear stress theory.  Fig Q2B	**3**	**5**	**1,3**	**1,2**	**3**
2C.	A person weighing 1000 N stands on the tip of a diving board of 1 m in length, as shown in Fig Q2C. If the deflection at the tip of the diving board is to be limited to 110 mm, select a suitable wood material for the diving board from the table Q2C. The diving board has a breadth of 300 mm and a depth of 20 mm. **Wood Material** / **Youngs Modulus** Alder Wood — 8.1 GPa Basswood — 7.2 GPa Birch — 10.3 GPa Oak — 12.5 GPa Walnut — 16 Gpa  Fig Q2C	**2**	**1**	**1,3**	**1,2**	**3**
3A.	A cast iron pinion running at 1200 RPM is to transmit 2kW to a cast iron gear (grade 25) gear running at 192 RPM. Teeth are of 20° full depth involute system. Allowable static stress for pinion might be taken as 48 N/mm^2. Minimum number of teeth is 15. Gears are expected to operate 8h/day with light shock loads. Calculate the module for the gears. Gears are ordinary cut.	**5**	**4**	**1,3**	**1,2**	**3**

3B.	A pair of spur gears have been designed with the following parameters. If the dynamic load is 9500 N, calculate the wear load and compare it with the dynamic load to check for its safety. Type of gear: Spur Pinion material: Steel :Youngs modulus=202 x10^3 N/mm^2 (BHN =200) Gear material: Steel:Youngs modulus=202 x10^3 N/mm^2 (BHN =200) Gear Profile: 20° stub tooth form Pinion diameter: 143 mm Gear diameter: 357mm Face width: 28.5 mm Weaker member: Pinion	**3**	**4**	**1,3**	**1,2**	**3**
3C.	A helical cylindrical spring is made from a wire of 6mm diameter and has an outside diameter of 75mm. If the permissible stress is 350 N/mm^2, and rigidity modulous is 84 kN/mm^2, find the axial load the spring can carry and the deflection per active turn.	**2**	**3**	**1,3**	**1,2**	**3**
4A.	A shaft of 600mm length between bearings must be designed to transmit 20kW from an electric motor of speed 100 RPM to a heavy-duty lathe headstock through a 400 mm diameter pulley by means of a belt drive, as shown in Figure Q4A. The shaft has an overhang of 100 mm from the nearest bearing carrying a pulley of 300 N at its end. The belt drive is vertical, and the motor is placed vertically below the pulley. The angle of the wrap in the belt with the pulley is 178 degreesand the coefficient of friction between the belt and the pulley is 0.3. Combined shock and endurance factors in bending and torsion are 1.25 and 1.75, respectively. Allowable shear stress is 93.6 MN/m^2. Design the shaft use maximum shear stress theory.  Fig Q4A	**5**	**5**	**1,3**	**1,2**	**3**
4B.	A power screw having double start square threads of 25 mm nominal diameter, 21mm core diameter is acted upon by an axial thrust of 10 kN. The outer diameter of the collar is 50 mm, and the inner diameter of the collar is 20 mm. The coefficient of friction at the screw is 0.2. The screw rotates at 12 RPM.	**3**	**4**	**1,3**	**1,2**	**3**

	Determine the torque required to raise the load and the power required to drive it. Take μ_c= 0.15.					
4C.	A material is loaded as shown in Fig Q4C. Determine the principal stresses and the angle made by the principal planes with the vertical.  Fig Q4C	**2**	**1**	**1,3**	**1,2**	**3**
5A.	Eight identical cylindrical compression springs are set in parallel at the bottom of a mine shaft to absorb shocks. In case of free fall of a loaded cage weighing 4kN from a height of 10m, find the maximum stress induced in the wire of each spring. The rigidity modulus of the material is 82 x 10^6 N/mm^2. The spring index is 6. Each spring has 15 turns. The spring wire diameter is 20 mm. Estimate the deflection of each spring.	**5**	**3**	**1,3**	**1,2**	**3**
5B.	A thin steel tube 50mm in diameter is 2mm thick. Find the safe twisting moment that can be applied to the tube if the allowable shear stress is 80MN/m^2. Also, find the twist that is 400 mm long. Take G=80 GN/m^2.	**3**	**1**	**1,3**	**1,2**	**3**
5C.	Select a single-row deep groove ball bearing to support a pure radial load of 2 kN from a shaft that rotates at 500 RPM. The expected life of the bearing is 30000 hrs. The minimum acceptable diameter of the shaft is 40 mm.	**2**	**4**	**1,3**	**1,2**	**3**