BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BTECH **SEMESTER : V**
BRANCH: PIE **SESSION : MO/2024**

SUBJECT: PE328 DESIGN OF MACHINE ELEMENTS

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions, each of 10 marks and a total of 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data handbook/Graph paper, etc., to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	"Maximum shear stress theory is more reliable as compared to maximum principal stress theory under the state of biaxial stresses of opposite nature" – Justify.	[5]	1	4
Q.1(b)	A load P = 44 kN is applied to a crankshaft at a distance of 200 mm from the bearing (Figure 1). The shaft is made of 30C4 steel with Syt = 276 MPa. Using the factor of safety of 2 and maximum shear stress theory, find the diameter of the shaft.	[5]	1	3

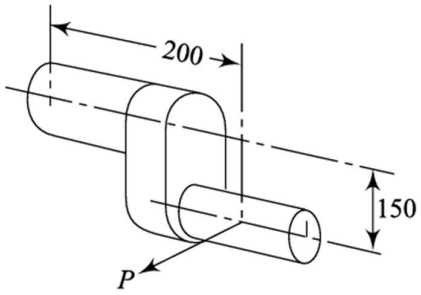

Figure 1

Q.2(a)	Draw a neat sketch of a cotter joint and write the equations of failure for the Spigot and Socket.	[5]	2	3
Q.2(b)	A cotter joint connects two rods, with the socket having an internal diameter of 40 mm and the socket collar having an external diameter of 80 mm. The rods are subjected to a tensile force of 50 kN. The cotter, made from 30C8 steel (Syt = 400 MPa), operates with a factor of safety of 4. The width of the cotter is designed to be five times its thickness. Calculate: (i)The width and thickness of the cotter considering shear failure. (ii) The width and thickness of the cotter considering bending failure.	[5]	2	3
Q.3(a)	Define the following terms: (ii) Major and Minor diameter, (ii) Pitch and Lead of threaded fastener. Explain the concept of a bolt of uniform strength and describe the methods used to achieve it.	[5]	3	2
Q.3(b)	A bracket is fastened to the steel structure by means of six identical bolts, as shown in Figure 2. Assume the following data: l_1 = 300 mm, l_2 = 200 mm, l_3 = 100 mm, l = 250 mm, P = 50 kN. Neglecting shear stress, determine the size of the bolts, if the maximum permissible tensile stress in any bolt is limited to 100 MPa.	[5]	3	3

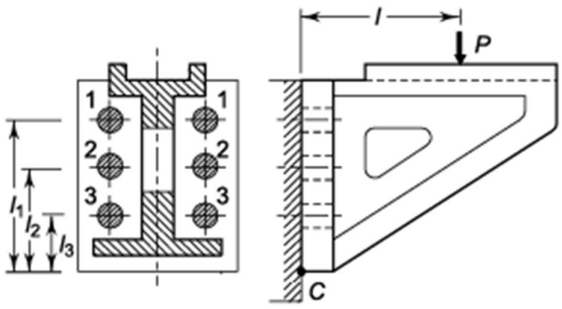

Figure 2

PTO

Table 1: Basic dimensions for ISO metric screw threads

Designation	Nominal or major dia d/D (mm)	Pitch (p) (mm)	Pitch diameter d_p/ D_p (mm)	Minor diameter (mm)		Tensile stress area (mm^2)
				d_c	D_c	
M 4	4	0.70	3.545	3.141	3.242	8.78
M 5	5	0.80	4.480	4.019	4.134	14.20
M 6	6	1.00	5.350	4.773	4.917	20.10
M 8	8	1.25	7.188	6.466	6.647	36.60
M 10	10	1.50	9.026	8.160	8.376	58.00
M 12	12	1.75	10.863	9.853	10.106	84.30
M 16	16	2.00	14.701	13.546	13.835	157

Q.4 A shaft is supported by two bearings placed 1 m apart. A 600 mm diameter pulley is mounted at a distance of 300 mm to the right of the left-hand bearing, and this drives a pulley directly below it with the help of a belt having a maximum tension of 2.25 kN. Another pulley 400 mm diameter is placed 200 mm to the left of the right-hand bearing and is driven with the help of an electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is 180° and μ = 0.24. Determine the suitable diameter for a solid shaft, allowing working stress of 63 MPa in tension and 42 MPa in shear for the material of the shaft. Assume that the torque on one pulley is equal to that on the other pulley. [10] 4 3

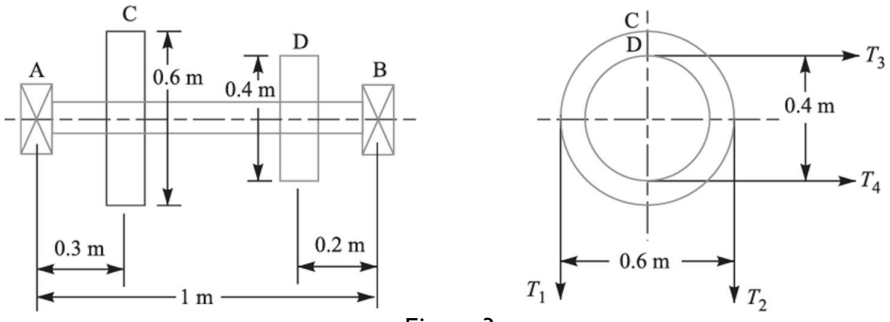

Figure 3

Q.5(a) A helical compression spring is subjected to an axial force, which varies from 2.5 kN to 3.5 kN. Over this range of force, the deflection of the spring should be approximately 5 mm. The spring index can be taken as 5. The spring has square and ground ends. The spring is made of patented and cold-drawn steel wire with an ultimate tensile strength of 1050 MPa and a modulus of rigidity of 81370 MPa. The permissible shear stress for the spring wire should be taken as 50% of the ultimate tensile strength. Design the spring and calculate
(i) wire diameter; (ii) mean coil diameter; (iii) number of active coils; (iv) total number of coils; and (v) solid length of the spring [5] 5 3

Q.5(b) A pair of spur gears with 20° full-depth involute teeth consists of a 20 teeth pinion meshing with a 41 teeth gear. The module is 3 mm, while the face width is 40 mm. The material for pinion, as well as gear, is steel with an ultimate tensile strength of 600 MPa. The gears are heat-treated to a surface hardness of 400 BHN. The pinion rotates at 1450 rpm, and the service factor for the application is 1.75. Assume that the velocity factor accounts for the dynamic load and the factor of safety is 1.5, determine the (i) beam strength and (ii) wear strength of the gears, and (iii) effective load acting on the gear tooth when the tangential load is 1160 N. [Lewis form factor is 0.32 for 20 teeth] [5] 5 4

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