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

CLASS: BTECH **SEMESTER: V/ADD**
BRANCH: PIE **SESSION: MO/2025**

SUBJECT: PE328 DESIGN OF MACHINE ELEMENTS

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

INSTRUCTIONS:
1. The question paper contains 5 questions, each of 10 marks, for 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 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)	Discuss the comparative merits and demerits of the Maximum Normal Stress Theory, Maximum Shear Stress Theory, and Distortion Energy Theory. Justify the selection criteria for each theory in the context of: Ductile vs. brittle materials, and Economic vs. safe design considerations.	[5]	1	5
Q.1(b)	The dimensions of an overhang crank are given in Fig. 1. The force P acting at the crankpin is 1 kN. The crank is made of steel 30C8 (Syt = 400 N/mm^2) and the factor of safety is 2. Using the maximum shear stress theory of failure, determine the diameter *d* at the section - XX.	[5]	1	3

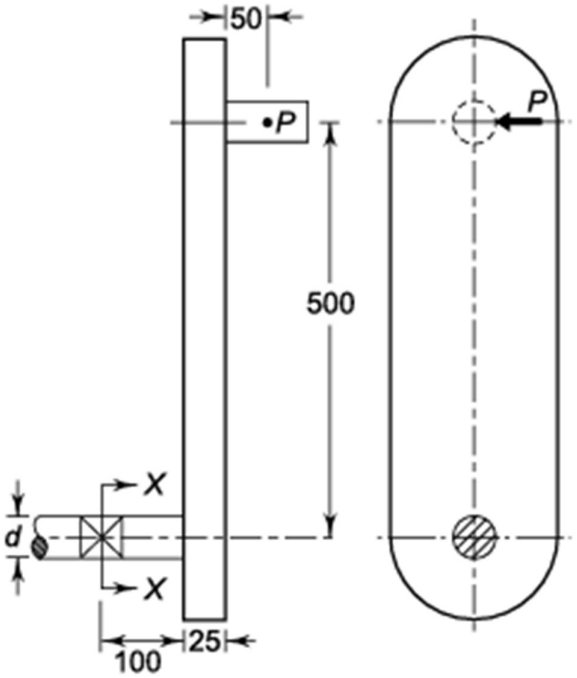

Fig. 1

Q.2	Design a cotter joint to connect two steel rods of equal diameter. Each rod is subjected to an axial tensile force of 50 kN. The rods, spigot, socket, and cotter are made of steel 30C8 (Syt = 400 N/mm^2). The yield strength in compression is twice that in tension. The factor of safety for the rods and spigot end is 6, while for the cotter, it is 4. Design the cotter and spigot end, and specify all the main dimensions by considering shear and bending failures of the cotter, and tensile, shear, and crushing failures of the spigot.	[10]	2	3

PTO

Q.3 A cylindrical pressure vessel with an inside diameter of 1.5 m is subjected to an internal steam pressure of 1.5 MPa (Fig. 2). It is made from a steel plate with a triple-riveted, double-strap longitudinal butt joint, featuring equal straps. The pitch of the rivets in the outer row is twice that of the pitch of the rivets in the inner rows. The rivets are arranged in a zigzag pattern. The efficiency of the riveted joint should be at least 80%. The permissible stresses for the plate and rivets in tension, shear, and compression are 80, 60, and 120 N/mm^2, respectively. Assume that the rivet in double shear is 1.875 times stronger than in single shear. A minimum corrosion allowance of 2 mm thickness is recommended. Design the joint and calculate: [10] 3 3

(i) thickness of the plate;
(ii) diameter of rivets;
(iii) pitch of rivets;
(iv) margin;
(v) Efficiency of joint

Number of rivets per pitch length	*Values of C*		
	Lap joint	*Single-strap butt joint*	*Double-strap butt joint*
1	1.31	1.53	1.75
2	2.62	3.06	3.5
3	3.47	4.05	4.63
4	4.17	–	5.52
5	–	–	6.0

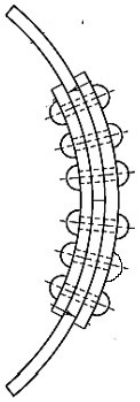

Fig. 2

Q.4 The layout of a transmission shaft carrying two pulleys, B and C, and supported on bearings A and D, is shown in Fig. 3. Power is supplied to the shaft by means of a vertical belt on the pulley B, which is then transmitted to the pulley C carrying a horizontal belt. The maximum tension in the belt on the pulley B is 2.5 kN. The angle of wrap for both the pulleys is 180°, and the coefficient of friction is 0.24. The shaft is made of plain carbon steel 30C8 (Syt = 400 N/mm^2), and the factor of safety is 3. Determine the shaft diameter on the strength basis. [10] 4 3

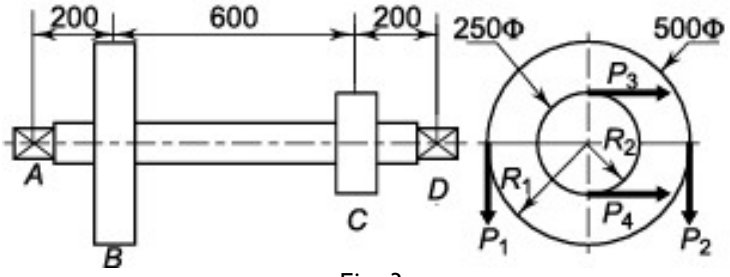

Fig. 3

Q.5 The lead screw of a lathe features single-start ISO metric trapezoidal threads with a nominal diameter of 52 mm and a pitch of 8 mm. The screw is required to exert an axial force of 2 kN in order to drive the tool carriage during the turning operation. The thrust is carried on a collar with an outer diameter of 100 mm and an inner diameter of 60 mm. The values of the coefficient of friction at the screw threads and the collar are 0.15 and 0.12, respectively. The lead screw rotates at 30 rpm. Calculate [10] 5 3

(i) the power required to drive the lead screw; and
(ii) the efficiency of the screw