

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

**CLASS: BTECH
BRANCH: PIE**

**SEMESTER: VI
SESSION: SP/2025**

SUBJECT: PE334 MACHINE TOOL DESIGN

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 got the correct question paper.
 5. Tables/Data handbook/Graph paper, etc., to be supplied to the candidates in the examination hall.
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		CO	BL
Q.1(a)	Explain the working principle and applications of the following mechanisms used in machine tools: (a) Pawl and ratchet mechanism, (b) Geneva mechanism.	[5] 1	2
Q.1(b)	Describe the working of Meander's mechanism in feed boxes and mathematically express how at least six different feed rates are achieved through its speed-changing kinematic arrangement.	[5] 1	3
Q.2	Design a 4-speed gearbox for transmitting 10 HP with speeds ranging from 400 rpm, with $\phi = 1.4$. Select a suitable structural form and the optimum ray diagram. Calculate the gear sizes, module, and width of the gears. Calculate the shaft size and draw the gearing diagram.	[10] 2	4
Q.3(a)	Prove that, if the failure of a simply supported beam with a central concentrated load is governed by normal stresses (due to bending), the volume of a mild steel beam required to withstand a given load is approximately 7 times less than that of a cast iron beam.	[5] 3	5
Q.3(b)	During the turning of a 200 mm diameter job in a lathe, the following cutting forces were recorded using a dynamometer: Axial force (P_x) = 100 kg, Radial force (P_y) = 40 kg, Tangential force (P_z) = 200 kg The distance between the two centers is $L = 1500$ mm, with $L_1 = 800$ mm and $L_2 = 700$ mm. The height of the centers is $h = 400$ mm. Calculate: (a) The force dissipation at the headstock and tailstock centers. (b) The maximum torque exerted on the lathe bed. Neglect the weight of the workpiece.	[5] 3	3
Q.4(a)	What is the major problem associated with the use of antifriction guideways caused by the lagging of rolling elements behind the moving member? Why does this occur, and how can it be addressed?	[5] 4	2
Q.4(b)	How does the compliance of machine tool spindle supports, represented by displacements δ_A (at the rear support) and δ_B (at the front support), influence the deflection of the spindle nose, and why does δ_B have a greater effect than δ_A according to the derived geometric relations?	[5] 4	3
Q.5(a)	Describe the working mechanism of a hydraulic pre-selective control system for speed changes in machine tools, highlighting its operational advantages, and include a neat sketch to illustrate the system.	[5] 5	2
Q.5(b)	Describe the spring-mass system in Van der Pol's model for machine tool chatter, considering the motion of the system on a belt moving with velocity (v), and explain how the kinetic frictional force, as a function of velocity, affects the differential equation governing the system.	[5] 5	4