K. K. Wagh Institute of Engineering Education & Research, Nashik

(An Autonomous Institute From A.Y. 2022-23)

WINTER-2025	
Exam Seat No.:	
Academic Year:2025-2026	Semester:V
Class:TY	Program:B.Tech
Branch Code:ROB	Pattern:2023
Name of Course:Robot Kinematics and Dynamics	Course Code:2312301
Max. Marks:60	Duration:2.30 Hrs.

Instructions: Candidates should read carefully the instructions printed on the Question Paper and on the cover page of the Answer Book, which is provided for their use.

1. This question paper contains 04 page(s).
2. Answer to each new question is to be started on a new page.
3. Assume suitable data wherever required, but justify it.
4. Draw the neat labelled diagrams, wherever necessary.
5. The last columns indicates the Course Outcome and level of Blooms Taxonomy of the Question/sub-question.

Marks CO

Question No. 1

1a) Obtain three precision points for a four bar mechanism used to generate a function $y = x^2 - 3$. Consider $4 \le x \le 10$. (6) CO1

Question No. 2

2a) The data for 3 robots with respect to purchase cost, programming flexibility, load carrying capacity and inaccuracy is collected as shown in Table. Attribute data and their weights for 3 robots is given in Table below: (6) CO2

weight	0.25	0.20	0.25	0.30
Attribute	Purchase cost (₹ in Lakh)	Programming Flexibility	Load carrying Capacity (kg)	Inaccuracy (mm)
Robot 1	58	High	28	0.12
Robot 2	42	Medium	19	0.18
Robot 3	64	High	35	0.14

Select the most suitable robot using simple additive weight method. Use 5 point scale for programming flexibility.

Question No. 3

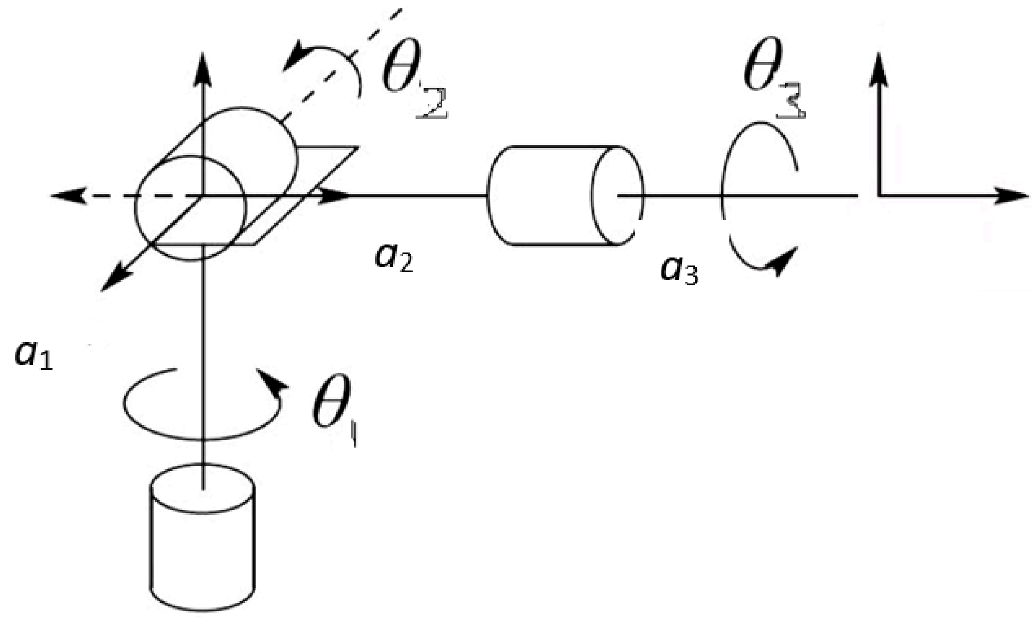
3a) Describe the following terms : (8) CO3

i) Forward kinematic for robot manipulators

(ii) Denavit–Hartenberg (DH) parameters

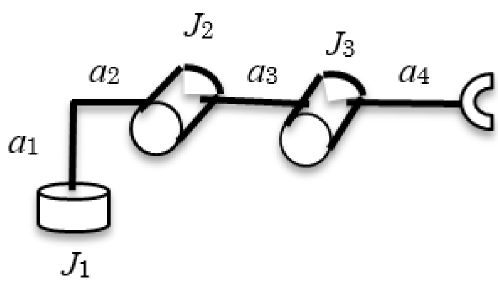
OR

3b) Obtain the DH parameters for the robot configuration shown in Fig. below. Also determine the position of end effector if the link lengths are: a_1=7 cm, a_2=9 cm, a_3 = 5 cm and the joint parameters are: θ_1 =44°, θ_2 =58°, and θ_3 =12°. (8) CO3



3c) Perform forward kinematic analysis of articulated robot shown in Fig. below: (8) CO3

Consider the values of joint parameters as J_1 = 36°, J_1 = 52°, J_1 = 18°, a_1 = 4 cm, a_2 = 6 cm, a_3 = 2.5 cm, a_4 = 5 cm.

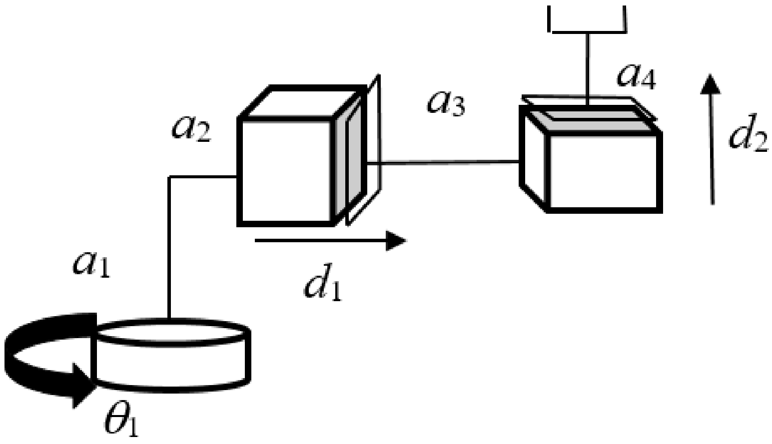


OR

3d) Explain with neat sketch the forward kinematic analysis of a cylindrical coordinate robot. (8) CO3

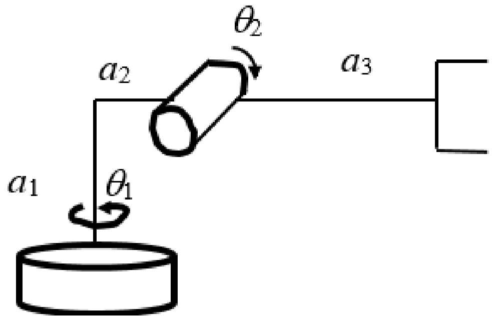
Question No. 4

4a) For the robot shown in Figure, use inverse kinematics to obtain the joint parameters θ_1, d_1, and d_2 to bring the robot end effector to the position (4.5, 3.15, 3.2). Consider a_1 = 1.5 m, a_2 = 2 m, a_3 = 3 m, a_4 = 1 m. (8) CO3



OR

4b) For the robot shown in Figure, use inverse kinematics to obtain the joint parameters θ_1, and θ_2 to bring the robot end effector to the position (2.07, 1.86, 3.60). Consider a_1 = 1.2 m, a_2 = 2.1 m, a_3 = 2.5 m. (8) CO3



4c) Perform one iteration of a steepest descent algorithm to minimize function $f = 2x_1^2.x_2 - 6x_1$ Consider initial solution as x1 = 1 and x2 = 1 (8) CO3

OR

4d) Explain with neat sketch inverse kinematics of Spherical coordinate robot. (8) CO3

Question No. 5

5a) Following data operates for a 2 DOF planer robot: (8) CO4

- Length of link 1= 0.5 m
- Length of link 2 = 0.3 m
- Mass of link 1= 1.5 kg
- Mass of link 2= 1.2 kg
- Angular position of link 1 = 30°
- Angular position of link 1 = 65°

If the links are of rectangular cross section with negligible width and height, determine the inertia tensor of link 1 in the base co-ordinate system.

OR

5b) A robot arm with revolute joint follows cubic polynomial $18+2.6\,t^2-0.203.t^3$. Determine the final angular position of the arm and the time taken by the arm to move from initial position to final position. (8) CO4

5c)	Explain the Recursive Newton-Euler algorithm to derive manipulators dynamic equations of motion.	(8)	CO4

OR

5d)	What is robot dynamics? What is its significance	(8)	CO4

····· End of question paper·····