



K. K. Wagh Institute of Engineering Education & Research, Nashik
(An Autonomous Institute From A.Y. 2022-23)

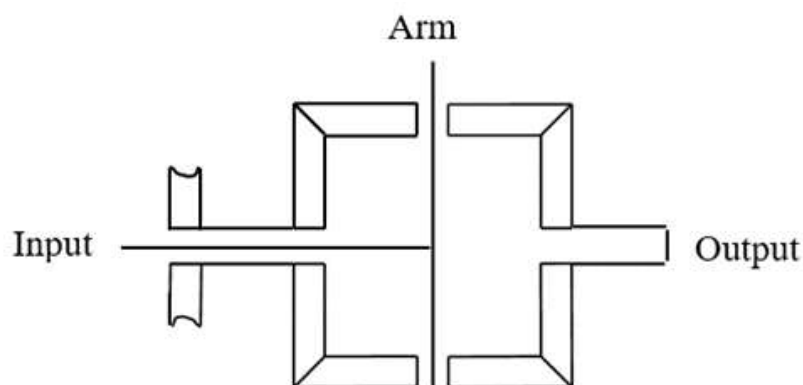
SUMMER-2024	
Exam Seat No.:	
Academic Year:2023-2024	Semester:IV
Class:SY	Program:B.Tech
Branch Code:ROB	Pattern:2022
Name of Course:Robot Kinematics and Dynamics	Course Code:ROB222011
Max. Marks:60	Duration:2.30 Hrs.

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 4 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.

Question No. 1 Attempt following Question

- 1a) A four bevel planetary block has been used in a robot such that output rpm is 10. Determine the input rpm if (6) CO1
the arm of the planetary wheel rotates at 25 rpm.

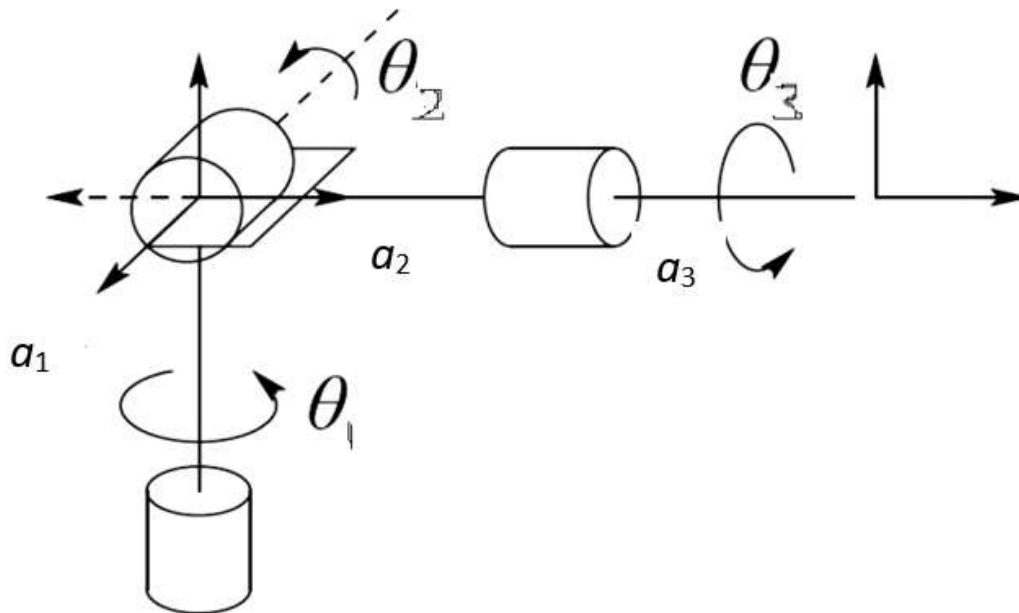


Question No. 2 Attempt following Question

- 2a) One of the joint of an industrial robot has type R joint with range 150° . The bit storage capacity of robot controller is 8 bits. The mechanical errors are normally distributed about taught point with mean zero and standard deviation of 0.04° . Determine the control resolution, accuracy, and repeatability for this joint. (6) CO2

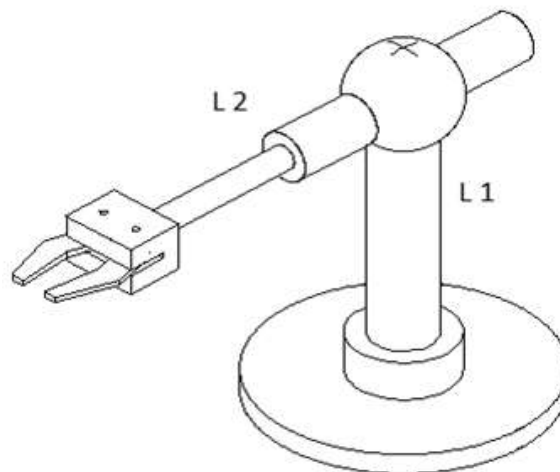
Question No. 3 Attempt following Question

- 3a) Obtain the DH parameters for the robot configuration shown in Fig. below. Also determine the position of end effector if the link lengths are: $a_1=100$, $a_2=110$, $a_3=70$ mm and the joint parameters are: $\theta_1=55^\circ$, $\theta_2=40^\circ$, and $\theta_3=30^\circ$. (8) CO3



OR

- 3b) What is robot forward kinematics? What are input and output parameters? Explain its applications in Robotics (8) CO3
- 3c) A spherical robot has link 1 length ($L1$) = 15 cm and link 2 length ($L2$) = 12 cm. Determine the gripper position for following transformations: (8) CO3
- Translation along X axis by 6 cm,
 - Rotation about Y by 30 Degree
 - Rotation about Z by 50 degree



OR

- 3d) What are Denavit–Hartenberg (DH) parameters? Explain the steps to determine these parameters. (8) CO3

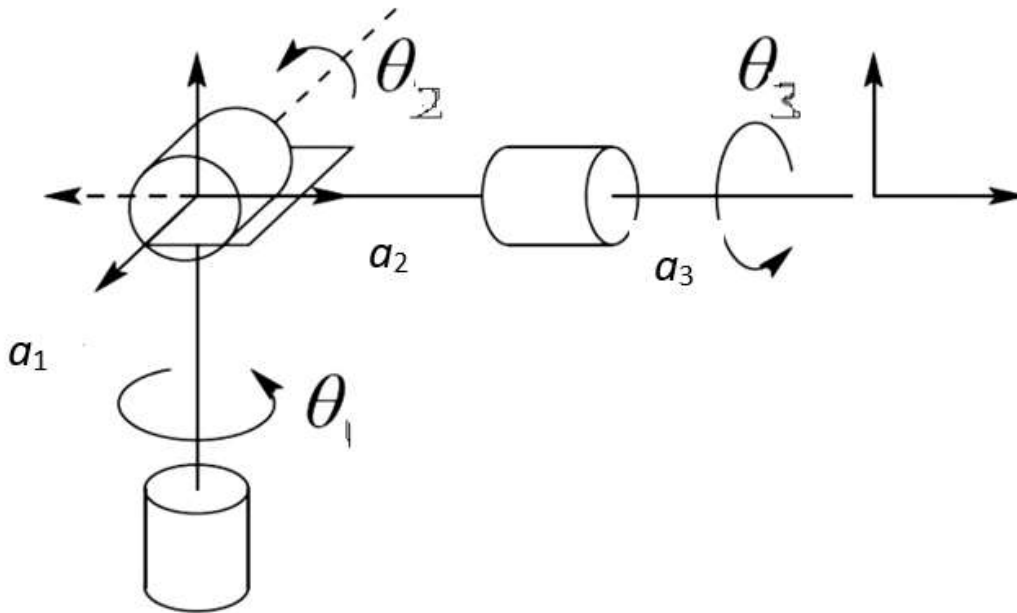
Question No. 4 Attempt following Question

- 4a) Formulate an inverse kinematic model for a SCARA robot and explain the application of steepest descent method to obtain the solution of this model. (8) CO3

OR

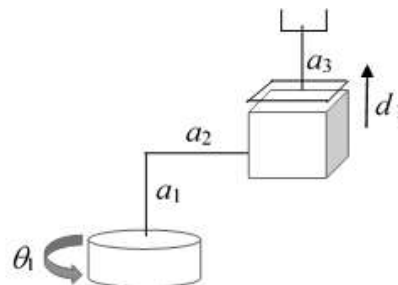
- 4b) Derive an expression for homogeneous transformation matrix for DH parameters. (8) CO3

- 4c) For the robot shown in Figure, use inverse kinematics to obtain the joint parameters θ_1 , θ_2 and θ_3 to bring the robot end effector to the position $(-25.8, -30.75, -7.34)$. Consider $a_1 = 50$ cm, $a_2 = 40$ cm, $a_3 = 30$ cm (8) CO3



OR

- 4d) For the robot shown in Fig., use inverse kinematics to determine the joint parameters θ_1 and d_1 to move the robot end effector to position $(8, 6, 25)$. The link lengths are: $a_1=12$ cm, $a_2=10$ cm, $a_3=8$ cm (8) CO3



Question No. 5 Attempt following Question

- 5a) For a single rotary manipulator link, the gripper force is $= [0, -40 \text{ N}, 0]$, mass of the link = 35 Kg, Angular velocity of link (ω) = 10 rad/s, Angular acceleration of link = -20 rad/s^2 , Length of link = 3 m with CG located at 2 m from joint. Determine the resultant joint reaction force in base co-ordinate system for angular position of 35° (8) CO4

OR

- 5b) A robot arm with revolute joint initially at angle moves to angle in time t following cubic polynomial motion: $-0.70 t^3 + 6 t^2 + 40$. Determine:
- Initial angular position of the arm
 - Time (t_f) required to move arm to final position
 - Final angular position of the arm
- (8) CO4

- 5c) Determine the Jacobian of link 1 and link 2 for $\theta_1=40$ degrees, $\theta_2=35$ degrees, for the two link planer robot having link lengths $L_1 = 3$ cm and $L_2 = 2$ cm (8) CO4

OR

- 5d) A two link planer manipulator having both linear joints has mass of link 1 = 4 kg and mass of link 2 = 3.5 kg. The equations of motion for two joints are $q_1 = 0.4t^3 - 0.3t^2 - 10$ and $q_2 = 0.3t^3 - 0.1t^2 - 12$. Where q_1 and q_2 are position vectors for the two linear joints. Determine the joint forces at $t = 5$ seconds. (8) CO4

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