



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 _____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

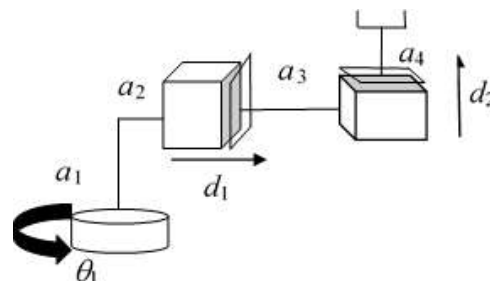
- 1a) In a four bar mechanism ABCD, the link AD is the fixed link and the dimensions of various links are: AB=50 mm, BC=100 mm, CD=150 mm, and AD=180 mm. For 40° inclination of input link AB, determine the angular displacement of output link CD. (6) CO1

Question No. 2 Attempt following Question

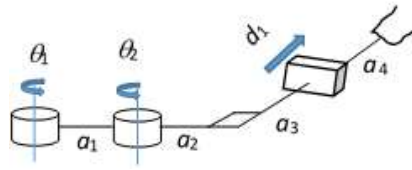
- 2a) With neat sketch explain the kinematics structure, advantages and applications of following robot configurations: (6) CO2
- (i) Cartesian robot (ii) Cylindrical robot (iii) Spherical robot (iv) articulated robot

Question No. 3 Attempt following Question

- 3a) For the robot shown in Figure, use forward kinematics to obtain the position of end effector for following values of joint parameters: $\theta_1 = 50^\circ$, $d_1 = 4$ cm and $d_2 = 6$ cm. Consider $a_1 = 30$ cm, $a_2 = 15$ cm, $a_3 = 40$ cm, $a_4 = 10$ cm. (8) CO3

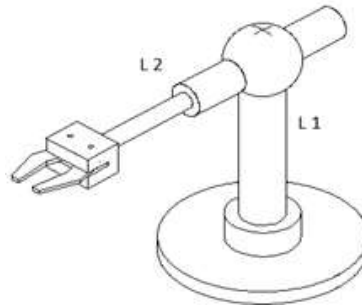


- 3b) For the robot shown in Fig., use forward kinematics to determine the position of end effector if the values of joint parameters are: $\theta_1 = 60^\circ$, $\theta_2 = 40^\circ$, and $d_1 = 3$ cm. The link lengths are: $a_1=20$ cm, $a_2=10$ cm, $a_3=12$ cm, $a_4=15$ cm. (8) CO3



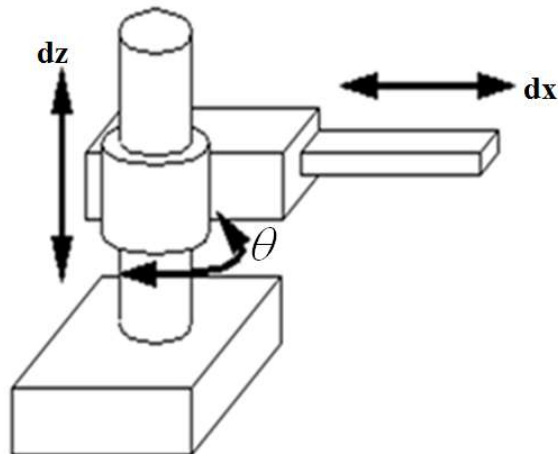
- 3c) A spherical robot has link 1 length ($L1$) = 10 cm and link 2 length ($L2$) = 14 cm. Determine the gripper position for following transformations: (8) CO3

- Translation along X axis by 5 cm,
- Rotation about Y by 50 Degree
- Rotation about Z by 40 degree



OR

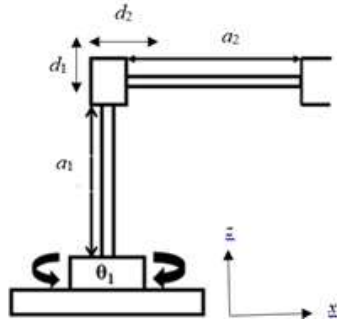
- 3d) For a cylindrical robot, the initial position of end effector is (5, 0, 3). Using 3D transformation method, determine the transformed position of end effector if the joint parameters are $\theta = 25^\circ$, $dx = 4$ units, and $dz = 2.5$ units. (8) CO3



Question No. 4 Attempt following Question

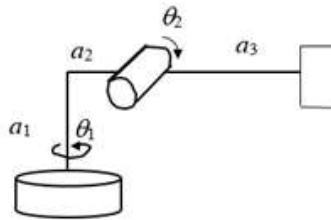
- 4a) For the cylindrical robot shown in Fig., prepare DH parameter table, obtain the inverse kinematics equations and determine the values of joint parameters θ_1 , d_1 and d_2 to move the robot end effector (8) CO3

to position (12, 15, 20). The link lengths are: $a_1=10$ cm, $a_2=6$ cm

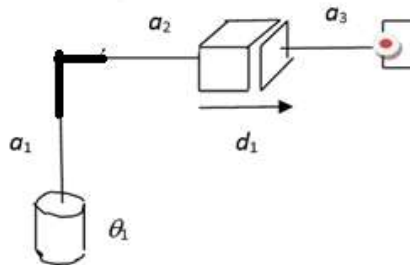


OR

- 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 (39.5, 22.8, 55.7). Consider $a_1 = 30$ cm, $a_2 = 15$ cm, $a_3 = 40$ cm (8) CO3



- 4c) For the kinematic diagram of robot as shown in Fig., Obtain the values of joint parameters θ_1 and d_1 to bring the end effector to position (4, 5, 3). The link lengths are: $a_1=3$, $a_2=2$, $a_3=1.5$ (8) CO3



OR

- 4d) Explain with suitable example, the application of pattern search method to solve the inverse kinematics problem. (8) CO3

Question No. 5 Attempt following Question

- 5a) For a single rotary manipulator link, the gripper force is $= [0, -30 \text{ N}, 0]$, mass of the link = 30 Kg, Angular velocity of link (ω) = 6 rad/s, Angular acceleration of link = -18 rad/s^2 , Length of link = 2 m with CG located at 0.8 m from joint. Determine the resultant joint reaction force in base co-ordinate system for angular position of 40° . (8) CO4

OR

- 5b) Obtain the equation of motion for angular velocity of a robot arm which moves from 20° to 80° in 5 seconds. (8) CO4

5c) Explain Newton-Euler formulation for manipulator dynamics

(8) CO4

OR

5d) What is forward robot dynamics? What are input and output parameters for forward dynamics?
Explain its applications in robotics

(8) CO4

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