

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering



Study Programme : Bachelor of Science Honours in Engineering
Name of the Examination : Final Examination
Course Code and Title : DMX7303- Control of Robotics Manipulators
Academic Year : 2024/25
Date : 31st January 2026
Time : 1330-1630h
Duration : 3 hours

General instructions

1. Read all instructions carefully before answering the questions.
 2. This question paper consists of five (5) questions on three (3) pages.
 3. Answer all questions.
 4. All questions carry equal marks.
 5. This is a Closed Book Test (CBT).
 6. The answer for each question should commence on a new page.
 7. Answers should be in clear handwriting.
 8. Do not use a RED pen.
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Question 1

- a) Explain the major industrial sectors where robotic manipulators are widely used and justify their adoption. [5 marks]
- b) Describe how robotics improves productivity, quality, and safety in manufacturing. [5 marks]
- c) Discuss the role of robotic manipulators in Industry 4.0 environments. [5 marks]
- d) Compare traditional automation with robotic automation in terms of flexibility and scalability. [5 marks]

Question 2

- a) Explain the role of Euler angle representations in describing rigid-body orientation in robotic manipulators. Discuss their advantages and limitations when used in kinematic modeling. [5 marks]
- b) Show that the rotation sequences XYZ and YZX can represent the same final orientation for a suitable choice of angles. Use a simple numerical example to demonstrate the equivalence. [5 marks]
- c) Formulate the homogeneous transformation matrix corresponding to the following sequence of rotations: 45° rotation about the OY-axis, followed by 30° rotation about the OZ-axis, and then 60° rotation about the OX-axis. [5 marks]
- d) The rotation matrix ${}^0R_3$, representing the orientation of frame {3} with respect to frame {0}, is given by the following matrix. Determine the corresponding ZYX Euler angles that define this orientation. [5 marks]

$${}^0R_3 = \begin{bmatrix} 0.50 & -0.61 & 0.61 \\ 0.79 & 0.61 & 0.05 \\ -0.36 & 0.50 & 0.79 \end{bmatrix}$$

Question 3

- a) Derive the forward kinematics of a 2-DOF planar manipulator using homogeneous transformations. [5 marks]
- b) Explain the concept of coordinate frames and their assignment to robot links. [5 marks]
- c) Formulate the transformation matrix between two adjacent links using Denavit-Hartenberg (D-H) parameters. [5 marks]
- d) Explain the physical meaning of each D-H parameter. [5 marks]

Question 4

Determine the forward Kinematics model of the Rhino XR-3 robot shown in Figure Q4 and obtain the endpoint transformation matrix. [20 marks]

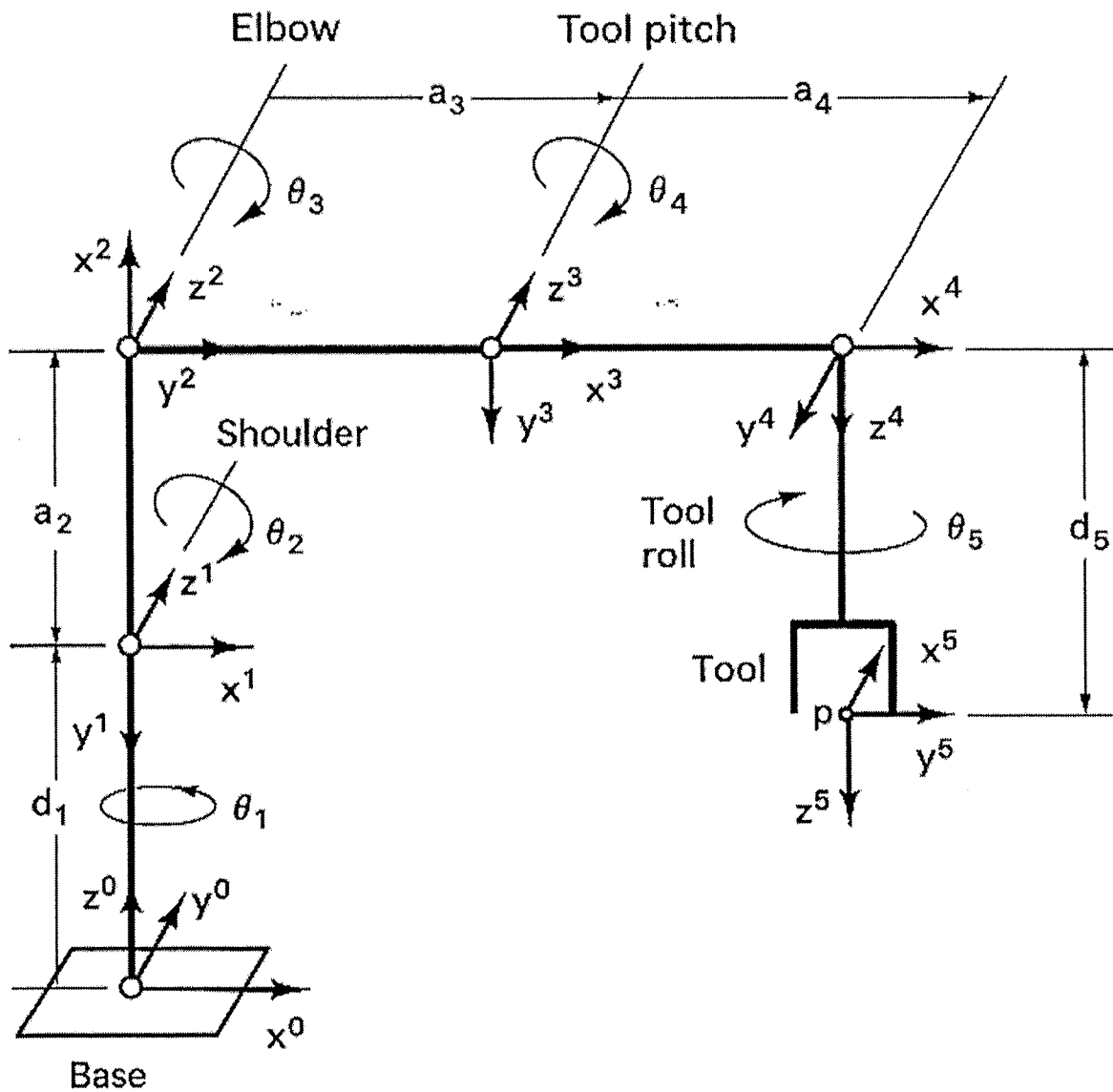


Figure Q4

Question 5

- Explain the objectives of trajectory planning in robotic manipulators. [5 marks]
- Explain the concept of trajectory tracking control. [5 marks]
- Explain the role of feed-forward terms in robot control. [5 marks]
- Evaluate the stability and performance of a robotic joint control system. [5 marks]

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