

**University of Saskatchewan
College of Engineering
Dept. of Mech. Engineering
ME 460.3 Mid-term Examination
February 2006**

Time: 1 Hour Instructor: Chris WJ Zhang
Close Book Exam (Write your work on the question paper directly)

Name: _____

Student Number: _____

This exam consists of **TWO** parts. Attempt all questions.

Part I. (40 marks)

1. Explain the general idea to perform motion analysis for robot manipulators (hint: think of coordinate systems). **[10]**

2. Explain the physical meaning of matrices ${}^B_A R$ and ${}^A P$. **[10]**

3. Given a matrix ${}^{i-1}T_i$ ($i=1, 2, 3, \dots, 6$), explain how to find the information about the angle between \hat{Z}_0 and \hat{Z}_2 . [20]

Part III (60 marks total)

Figure 1 (the next page) shows a robot manipulator whose structure and geometry are supposed to be known.

1. Set up (with a proper explanation) a coordinate system for each body of the manipulator based on the D-H notation (do the work on the figure directly). [20]
2. Fill in the first row ($i=1$) in the following table. [15]
3. Write out the transformation matrix 0T_1 . [10]
4. Write out the origin of the frame 1 with respect to the frame 0. [15]

I	α_{i-1}	a_{i-1}	d_i	θ_i

The general transformation matrix is given below:

$${}_{i-1}T_i = \begin{bmatrix} c\theta_i & -s\theta_i & 0 & a_{i-1} \\ s\theta_i c\alpha_{i-1} & c\theta_i c\alpha_{i-1} & -s\alpha_{i-1} & -s\alpha_{i-1}d_i \\ s\theta_i s\alpha_{i-1} & c\theta_i s\alpha_{i-1} & c\alpha_{i-1} & c\alpha_{i-1}d_i \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

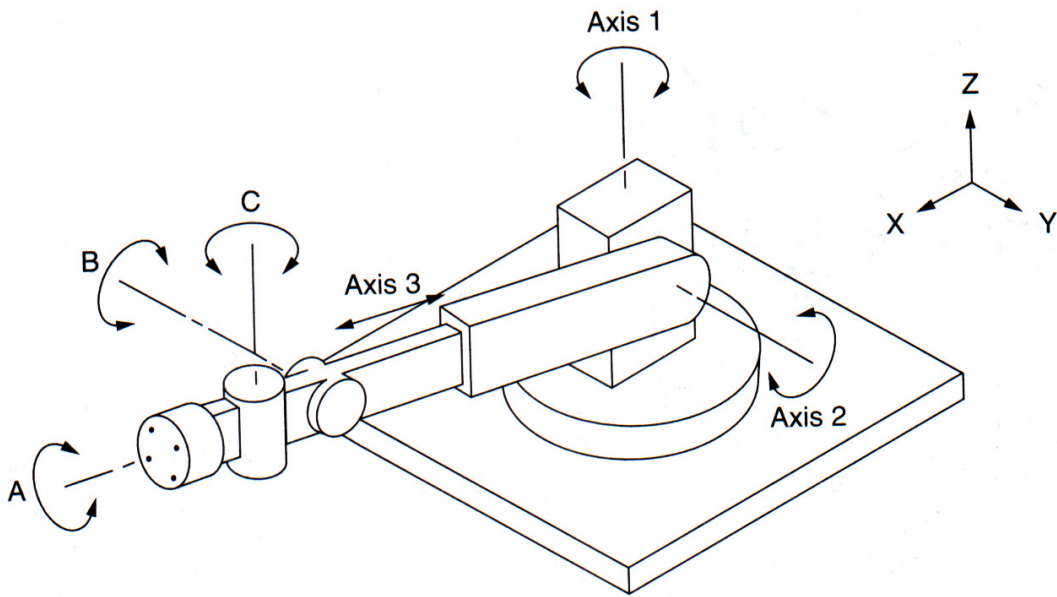


Figure 1

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