

King Saud University
College of Computer and Information Sciences
Computer Engineering Department

Second Semester, 1428/1429 Academic Year.
CEN459 - Robotics
Mid Term Exam I

Time: 90 minutes

15/04/1429 - 21/04/2008

Student Name:

Student No:

Write your answers on these pages and show all your work and write clearly. If you feel that a question is not fully specified, state any assumptions you need to make in order to solve the problem.

<u>Question</u>	<u>Score</u>	<u>Max Score</u>
1	_____	6
2	_____	7
3	_____	7
<hr/>		
TOTAL	_____	20

Question 1:

- a.** Compute the homogeneous transformation matrix representing a translation of 3 units along x-axis followed by a rotation of $\pi/2$ about the current z-axis followed by a translation of 1 unit along the fixed y-axis. Sketch the frames. What is the coordinates of the origin o_1 with respect to the original frame.
- b.** For the figure below, find the Matrix 0A_1 .

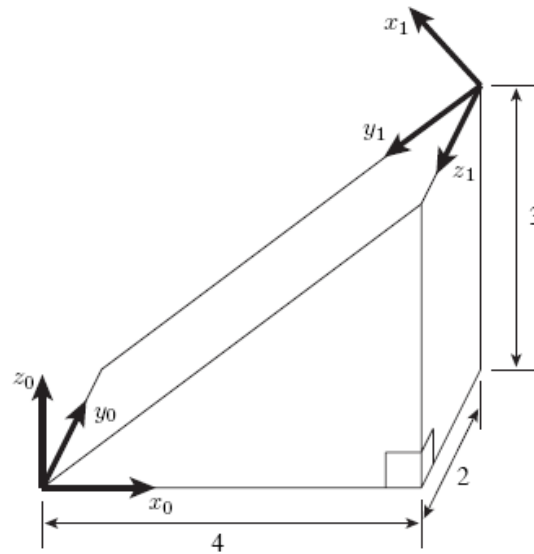


Fig. 1

Question 2:

For the SCARA manipulator showed schematically below:

- How many degrees-of-freedom does this manipulator has?
- Affix link frames according to the Denavit-Hartenberg methodology.
- ** Find the Homogeneous matrix 0T_E and deduce the forward kinematics equations.

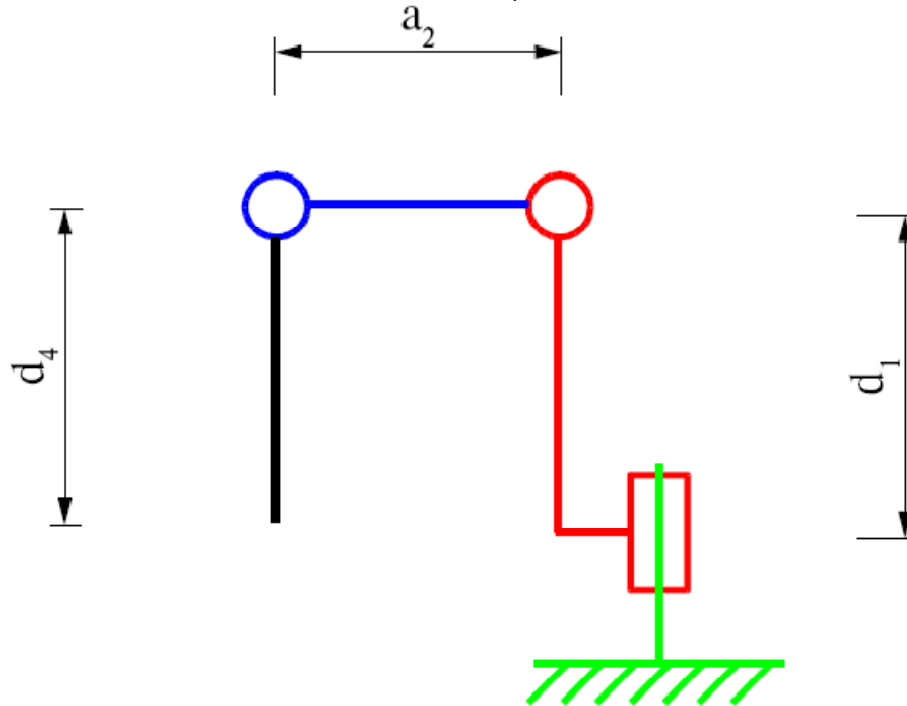


Figure 2

Hint: ${}^{i-1}A_i = \begin{bmatrix} c\theta_i & -c\alpha_i s\theta_i & s\alpha_i s\theta_i & a_i c\theta_i \\ s\theta_i & c\alpha_i c\theta_i & -s\alpha_i c\theta_i & a_i s\theta_i \\ 0 & s\alpha_i & c\alpha_i & d_i \\ 0 & 0 & 0 & 1 \end{bmatrix}$.

Question 3:

Given a two-link planar robot manipulator with $a_2=a_3=1\text{m}$.

- By using forward Kinematics, fill the table below:

θ_1	0	30	60	90	90
θ_2	0	0	30	60	90
X					
Y					

- Derive the Inverse Kinematics and fill the table below:

X	2	1	0	0.707	-1
Y	0	1	2	1.707	1
θ_1					
θ_2					

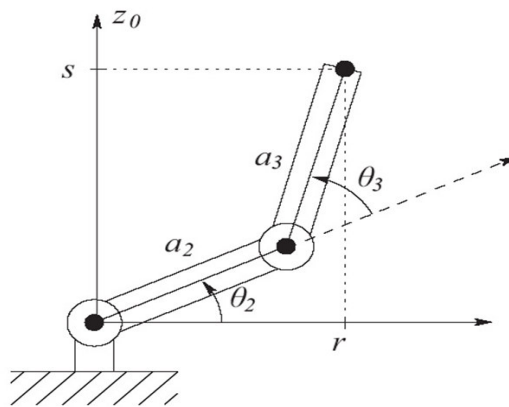


Fig. 3