# The City College of New York

CS/CpE/EE Joint Senior Design Program on
Smart Living and Assistive Technologies for People in Need
Instructors: Zhigang Zhu, Jizhong Xiao

Assignment #1 (Due Nov 05, 2018)

Note: **All the writings must be in soft copies (PDF). Please send the writing report (in PDF) to Prof. Xiao <jxiao@ccny.cuny.edu> as an email attachment.** You are responsible for the loss of your submission if you don't include "**Capstone 2018** " (exactly) in the **subject** of your email.

1. The robots are used because they can perform 4A job in 4D environment. What is 4A and 4D stand for? (8 points)

2. What is the rotation matrix for a rotation of 30º about the OZ axis, followed by a rotation of 60º about the OX axis, followed by a rotation of 90º about the OY axis? (12 points)

3. For the figure shown below, find the 4×4 homogeneous transformation matrices $^{i-1}A_i$ and ^0A_i for i=1, 2, 3, 4. (30 pints)

    Note: can you find the answer by observation based on the geometric interpretation of homogeneous transformation matrix?
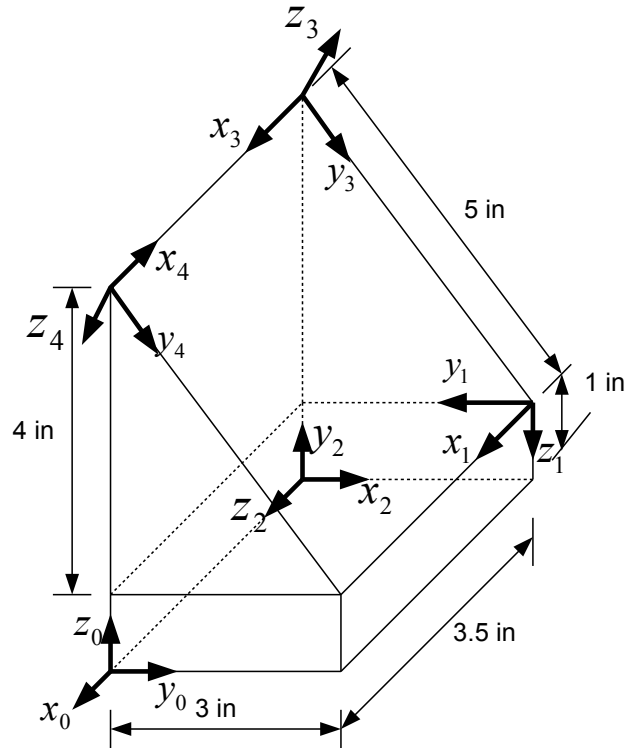
4.   What is the physical meaning of non-holonomic constraint? Among the five drive systems (differential drive, tricycle, synchronous, Ackerman Steering, omni-directional drive), which satisfy the non-holonomic constraint, which don't? (20 points)

5. How to determine the motor speed and direction using an optical incremental encoder? (20 points)

6. What is the Shannon's Sampling Theorem? (10 points)