TTE-5036 Control in Robotics and Automation exam

12th of May 2009

QUESTION 1:

a) Define inverse and forward kinematics
b) Define inverse and forward dynamics
c) Describe the concepts of path and trajectory

QUESTION 2:

a) Compare Lagrange and Newton – Euler approaches to manipulator dynamics formulation. Which one is more suitable for the implementation in computer systems? Why?
b) What is the role of inertia tension matrix I? In relation to the robot manipulator definition, when we may need to define the matrix? What is the meaning of the element i11 in the matrix?

$$I = \begin{matrix} i_{11} & i_{12} & i_{13} \\ i_{21} & i_{22} & i_{23} \\ i_{31} & i_{32} & i_{33} \end{matrix}$$

QUESTION 3:

a) Robotic toolbox: sketch structure and assign the frames to following robot, using standard Denavit-Hartenberg notation.

```
L1 = link ( [ pi/2 0 0 4 0 ] );
L2 = link ( [ pi/2 3 0 0 0 ] );
L3 = link ( [ pi/2 2 0 0 0 ] );
L4 = link ( [  0    1 0 0 0 ] );

r = robot ( { L1 L2 L3 L4} );
```

b) What is the position of the end-effector for the following joint variables?

- [0 0 pi/2 pi/2]

QUESTION 4:

Define SCADA. What role it has in automation system? Can OPC specifications help? If yes, then in which way?

QUESTION 5:

a) What are the programming languages defined in IEC 61131-3? Exemplify each of them using the following expression:

- If sensor S1 is ON and sensor S2 is OFF, then turn ON the output M4

b) Why there are number of languages defined in the standard? How does this affect the control application?