MA4825 Robotics Assignment

Assignment (Due 16/11/24@2359hrs, Saturday)

Instructions:

1. Answer all questions.
2. Show all your workings and drawings clearly.
3. Submit online thru MA4825 ntulearn course channel> Assignment> MA4825 Assignment 2 submission.

Question 1

The robot in Figure 1 consists of a rotating links (link 1 and 3) and a translational links (links 2). The angular displacements of rotational joints are θ and β, and the displacements of the translational joints are d. Link 1 is rotating with a constant angular velocity of $\dot{\theta}$ about the Z-axis; link 2 is translating horizontally at constant velocity of $\dot{d}$; link 3 is rotating with a constant angular velocity of $\dot{\beta}$ about the X-axis. Note that the configuration shown in the figure is the initial position of the system where $\theta = \beta = 0°$ and $d = K_1$. Find the absolute velocity of the end point P of the robot in terms of θ, β, and d. (25 marks)

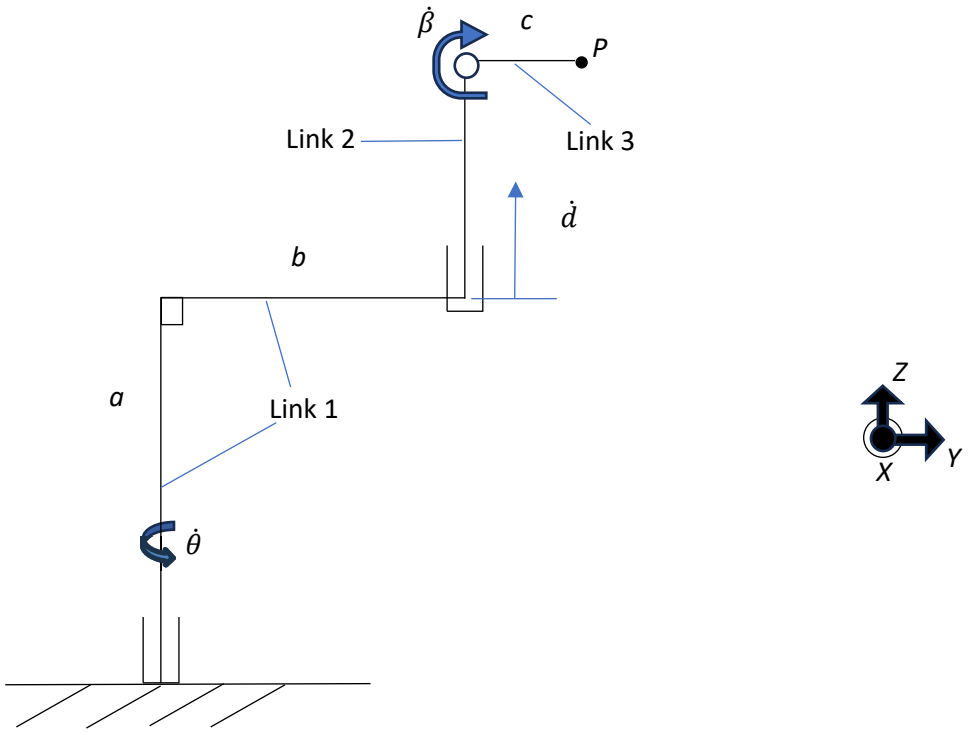

Figure 1

Question 2

An illustration of an industrial robot (ABB IRB 5720 robot) used for spotwelding is shown in Figure 2 without its end effector and in its initial position. The arm has six joints: $\boldsymbol{q} = \{\theta_1, \theta_2, \theta_3, \theta_4, \theta_5, \theta_6\}^T$.

(a) Given the base coordinate system, draw and specify the right-handed coordinate systems i (i = 1 to 6) of the robot up to the wrist joint. (Note: Sketch a skeletal diagram in isometric view & provide the positions and directions of the coordinate systems in your answer, take note of the positive directions.)

(10 marks)

(b) Tabulate the Denavit-Hartenberg (D-H) parameters for the position of the robot shown in Figure 3 for joints 1 to 6, according to the coordinate systems specified in part (a). Note that $\theta_i (i$ = 1 to 6) are the joint variables.

(6 marks)

(c) Find the generic D-H matrix $\boldsymbol{H}_{03}$ for the robot where $\boldsymbol{H}_{14}$ is a 4 x 4 homogeneous matrix transforming a vector from frame 3 to frame 1.

(4 marks)

(d) Figure 3 shows a schematic of the robot from link 1 to link 2 moving θ_2 and θ_3 respectively from its initial position. Assume a point mass m_1 and m_2 acting at point b and c respectively. Derive the Lagrangian L of the system.

(5 marks)

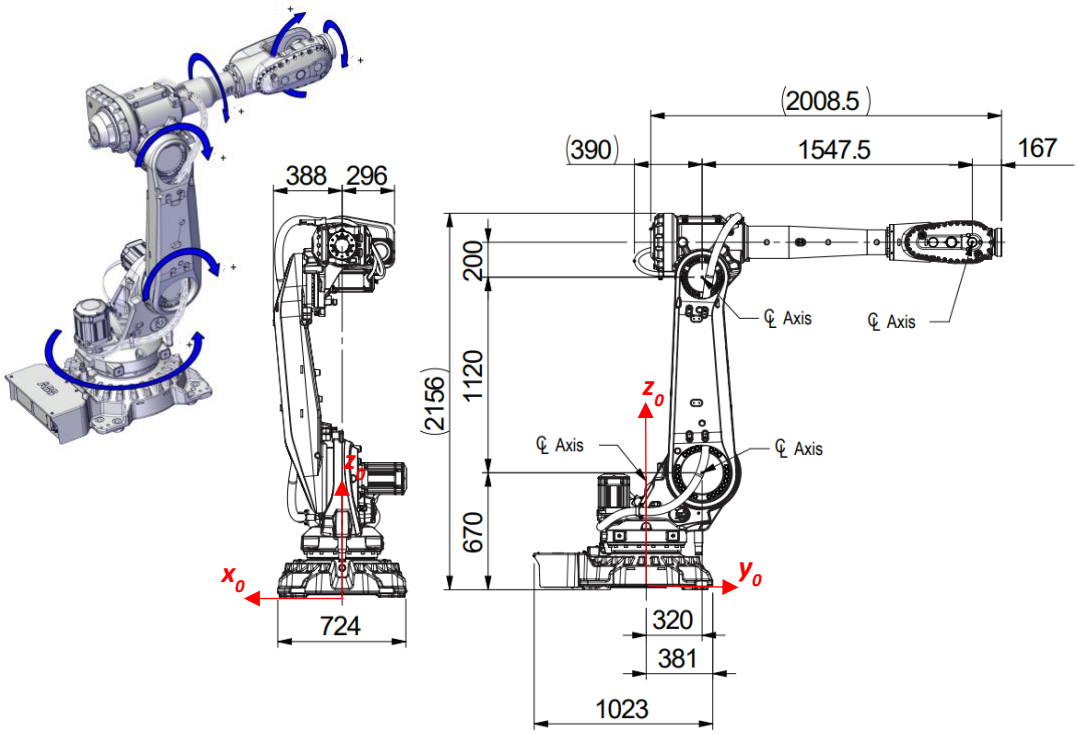

Figure 2

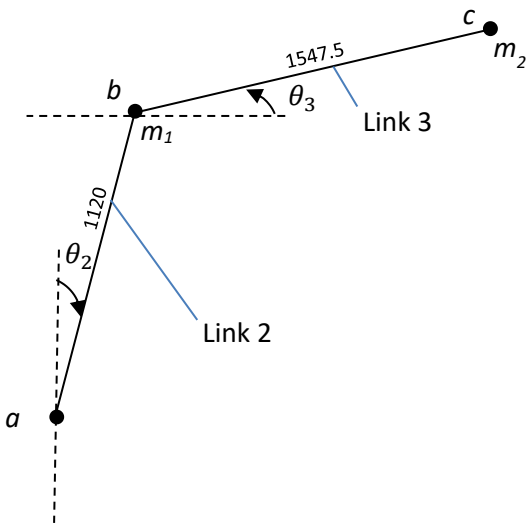

Figure 3

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