MA4825 Robotics Assignment

Assignment (Due 11/10/25@2359hrs, Saturday)

Instructions:

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

Question 1

Figure 1 shows a tool-joint with 2 DOFs with coordinate frame *XYZ* fixed at point *O* and frame *xyz* at point *o* rotating with the bracket. It consists of a motor mounted on a bracket with a yaw about the *Z*-axis tilted about the *x*-axis at an angle $\gamma = 40°$. The bracket rotates at a constant rate of $\dot{\beta} = 3$ rad/s while the motor rotates the disk at a constant rate of $\dot{\theta} = 60$ revs/min. Answer the following:

i. Calculate the absolute angular velocity and absolute angular acceleration of the disk. (5 marks)

ii. Determine the absolute velocity and acceleration of point *A* when it is located as shown in Figure 1. (8 marks)

iii. Subsequently, determine the absolute velocity and acceleration after the disk has rotated 90 degrees from part ii. Give the answer in terms of the fixed frame *XYZ*. (12 marks)

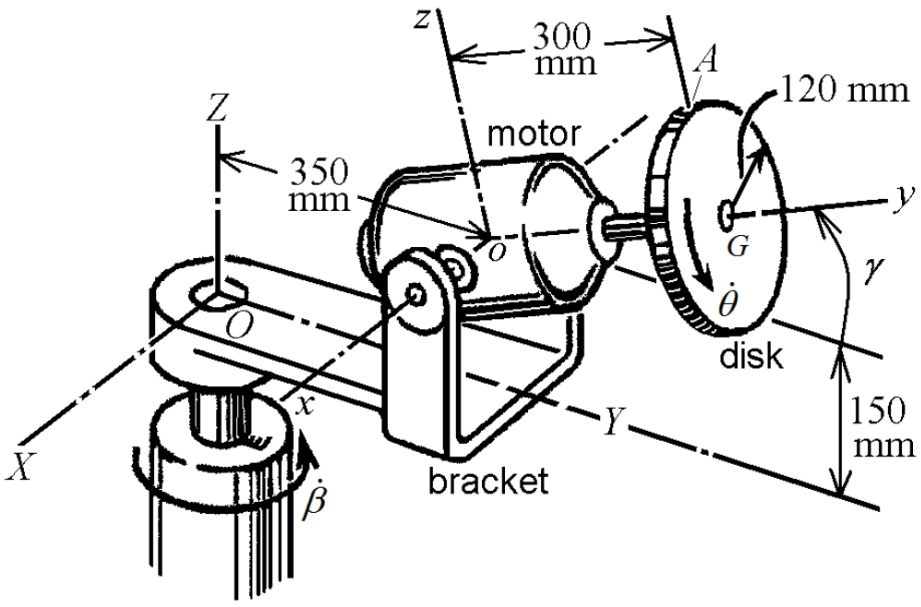

Figure 1

Question 2

A robot arm with a gripper consisting of 3 rotational links (i.e. links 1, 2 and 3) and 1 translational link (i.e. link 4) is shown in Figure 2. The angular displacement of rotational joint 1 to 3 is θ_1, θ_2 and θ_3 respectively and the displacement of the translational joint is c Links 1, 2 and 3 are rotating with a constant angular velocity of $\dot{\theta}_1, \dot{\theta}_2$ and $\dot{\theta}_3$ while the translational velocity of link 4 is $\dot{s}_4$. Note that the configuration shown in Figure 2 is the initial configuration i.e. $\theta_{1-4} = 0$ and the joint position of link 4 is at its home position. Note as well that the centroid of each link is located at the mid-point of the respective link. Answer the following:

i. Define the position vector of tool-point P with respect to O_1. (5 marks)
ii. Define the Jacobian matrix $[J]$ of the robot arm. (8 marks)
iii. Express the steps to find the kinetic and potential energies of the entire system and the Lagrangian. Note that the masses of links 1 to 4 are m_{1-4} respectively and the mass moment of inertia of each link with respect to each centroid are I_{c1-4} respectively. (12 marks)

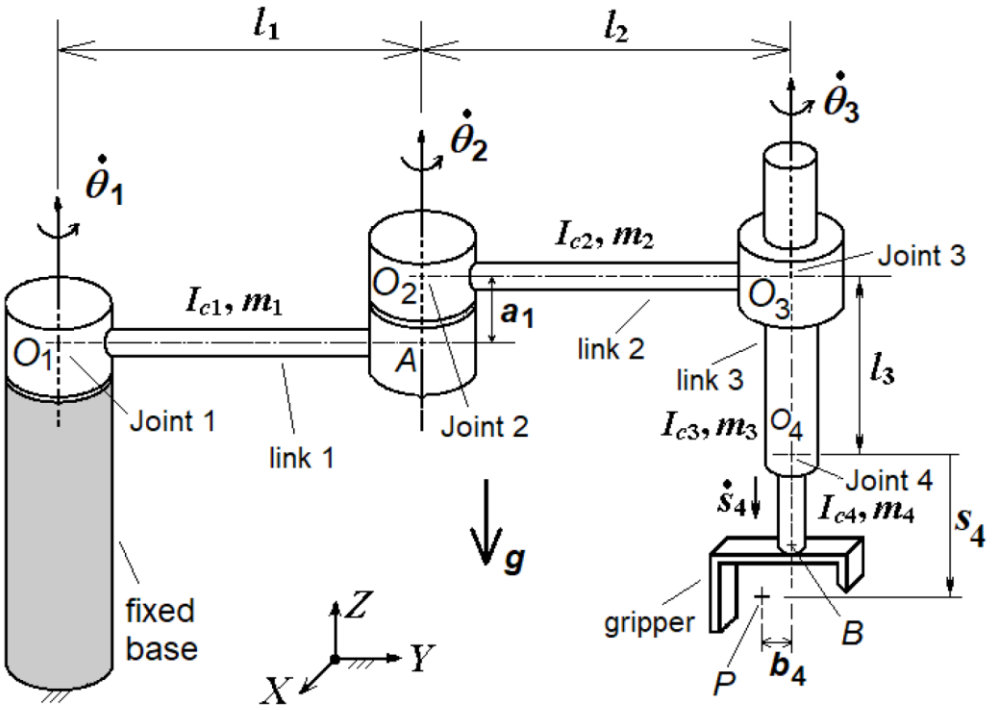

Figure 2