

**University of Maryland- College Park**  
**ENPM662 Introduction to Robot Modeling - Fall 2021**

**Homework - 5**

**Due Date: November 28th 2021 11:59 pm**

**Total - 50**

**Problem : KUKA WIIA dynamics**

Consider a KUKA WIIA robot with a pen (L=10 cm) attached as the end effector of the robot along Z direction of the local frame (Figure 1). **Assume that joint 3 is locked and will not be able to move so the Jacobian matrix is square matrix.**

Assuming the robot motion is quasi-static ( $\dot{q} \cong 0 \wedge \ddot{q} \cong 0$ ), calculate joint torques that is required to compensate the robot weight and ensure that pen is pushed against the wall with 5 N while drawing the circle (Figure 2).

Find mass information from KUKA WIIA datasheet.

**Deliverables:**

**Step 1-** Python code that parametrically calculates matrix  $g(q)$

**Step 2-** Python code that parametrically calculates total joint torque (gravity + external force)

**Step 3-** If robot draws the circle in 200 seconds, plot the joint torques required over time (between  $t=0$  and  $t=200$  s). (Plot 6 graphs. One of each joint: 1, 2, 4, 5, 6, and 7)

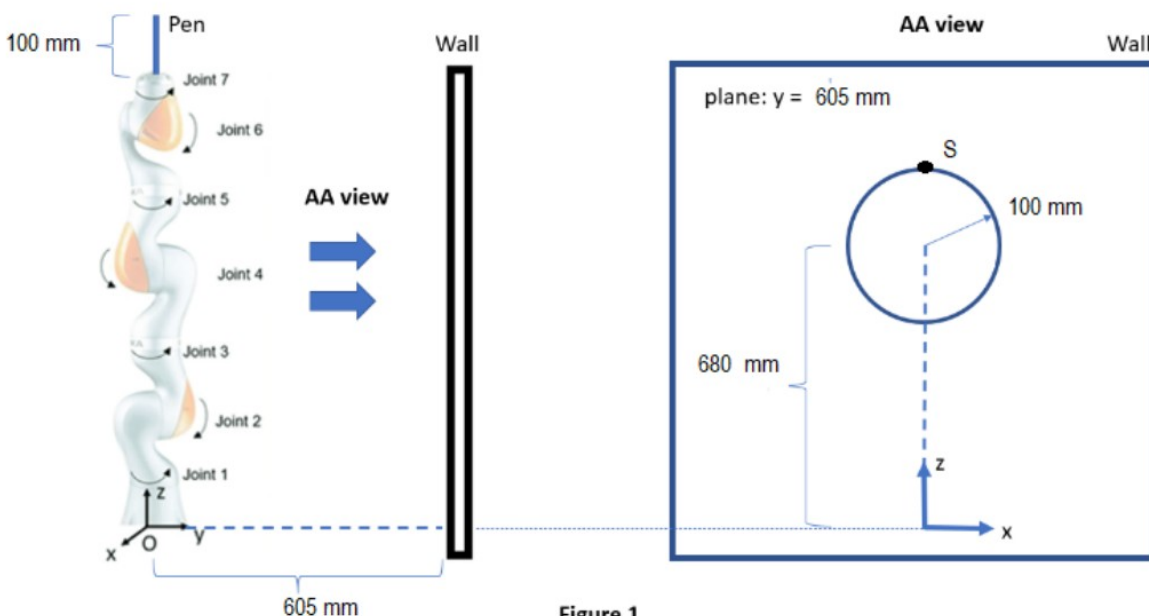


Figure 1

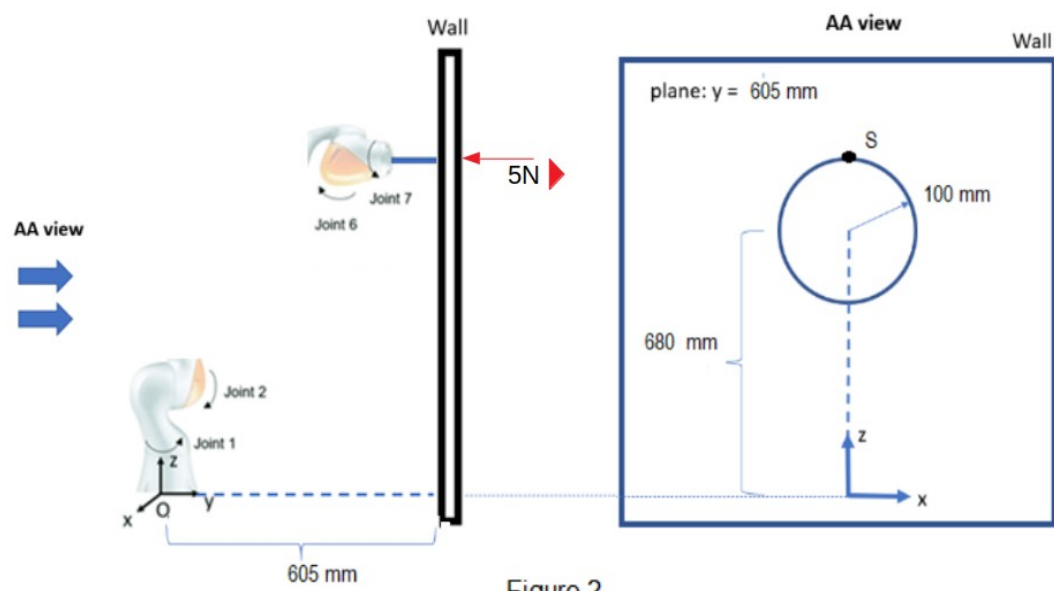


Figure 2