Robotic Manipulation – ELEC60030

Coursework 2026 – Robot Arm Modelling and Control

Evaluation

The coursework consists of four tasks which will be evaluated via the following three methods:

1. Report – 75 marks (37.5%)

The report has a maximum length of **3 pages** + appendix.

The report should describe your choice of frame assignments and approach to inverse kinematics. It should also motivate your choice of Task 3, while describing the challenges of the task.

The appendix should contain your inverse kinematics calculations and screenshots of any CAD models you have created.

2. Video Demo – 65 marks (32.5%)

The video demo should show your robot completing tasks listed in this document. Each task has videos associated with it. The videos will be based on pre-defined task parameters (such as cube location and orientation for Task 2).

You must submit a single video file demonstrating your robot completing the various tasks. You should film this with your smartphone, in landscape orientation, using the provided tripod and adapter. Choose a good camera angle that shows relevant aspects of the robot and object. You should edit out irrelevant footage and combine the relevant footage to appear in sequence. Use text to display your team name and team members at the start of the video. You can be creative with the video, using music, transitions, etc.

3. Live Demo – 60 marks (30%)

All groups typically demo their work on 'demo day' in week 10. Due to the size of this year's cohort, we may need to have two demo days. For your demo day you will have to show your robot completing tasks 2 and 3.

New parameters for Task 2 (object locations and targets) will be provided at **8am** on demo day. We use new parameters for demo day to make sure that your solutions are generalisable. Demos will be evaluated by the module leader and GTAs.

Housekeeping

All work will be carried out on the Robotis Manipulator-X robot.

Programming and simulations should be carried out only in Matlab.

You will need to hand in your code, which should run in a self-contained fashion without reliance on external libraries or code.

You cannot use the Matlab Robotics Toolbox. This makes things too easy and negates the learning outcomes.

You cannot use any code or libraries from Matlab File Exchange. That place is a wild west of poor resources.

Please leave the robots as you expect to find them. If you change the baud rate, PID controllers or anything else, change it back when you are done.

When you submit your coursework on blackboard, you should zip your Matlab files but leave the pdf of your report unzipped. This makes marking easier. Use compression tools (like HandBrake) to reduce the size of your video file.

Tasks

Task 1 - Model the robot

This task can be done at home without the robot present. It is important to do this task well, as it will generate the controller you need for the rest of the coursework.

<table>
<tr><td>1.a.</td><td>Assign co-ordinate frames to the robot and create a DH notation table. Illustrate and explain your frame choices in the report.

Note that there are multiple ways to assign frames to the robot. Some will lead to more complicated equations than others.

The dimensions of the robot are in the appendix.</td><td>10</td></tr>
<tr><td>1.b.</td><td>Create a graphical simulation of the robot, based on your DH Table. This only needs to consist of line() objects in Matlab. Increasing the thickness of the line can make the simulation easier to see, particularly after video compression.

Plot the co-ordinate frames (as I do in class, with appropriate colours) for additional marks.

Run forward kinematics by increasing each joint angle independently. This is a good way to ensure that your DH parameters make sense.

Make a video demonstrating your forward kinematics simulation. You can use a screen recorder or the video functions built into Matlab.</td><td>9</td></tr>
<tr><td>1.c.</td><td>Determine a solution to the inverse kinematics for a frame located between the jaws of the gripper.

Numerical solutions will receive less marks than analytic solutions.

For analytic solutions, it helps to consider the robot as subsystems. It also helps to only consider the position components of the gripper.

Write out your solution in the report.</td><td>12</td></tr>
<tr><td>1.d.</td><td>Re-run your simulation with the inverse kinematics.

Get your robot to trace a square of 10 x 10 cm in each cartesian plane. Be sure to draw the square (use line objects of different colours).

Make a video of this.</td><td>9</td></tr>
<tr><td></td><td align="right">Total marks for Task 1</td><td>40</td></tr>
</table>

Task 2 – Pick and Place

2.a.	Move the three cubes to the empty cube holders (2 points per cube) Smoothness and Time (3 points)	**9**
2.b.	Stack all the cubes on one of the empty cube holders (1 point per cube) Rotate the cubes so the red faces face outwards (1 point per cube) Do not touch the gates or bridge while picking up the covered cube (4 points) Smoothness and Time (3 points)	**16**
2.c.	Move the tool through the gates (2 points per gate) Do not touch the gates (0.5 points per gate) Tool tip below line on gates (0.5 points per gate) Smoothness and Time (3 points)	**15**
	Total marks for Task 2	**40**

Task 3 – Own Task

Using what you have learned during the course, come up with a robot manipulation task and execute it with your robot.

You can use physical props to make your task more realistic, and it is fine to scale these to the size of the robot. Props can be purchased (must be <£10) or 3D printed (look for files on Thingiverse.com before designing them yourself). Consider using the holes in the baseplate to help position your props.

Note that tasks cannot involve actual liquids. You can either pretend that your coffee container has liquid in it, or you can use a granular material with grains larger than 4mm. Something like rice or dry chickpeas would work. You must clean up any spilled grains.

3.a.	Originality – selection of an interesting / novel task. The task needs to be motivated by some idea / application. This can be as simple and fun as 'giving me a drink when I'm working late' or more industry focused such as 'packing groceries at a warehouse'. You will have a few minutes at the start of your demo for an 'elevator pitch' to describe what you are attempting to do.	**10**
3.b.	Challenge – don't choose a task that is too easy to complete. Select something that requires demonstration of the knowledge you have learned during the course. The more challenging the task, the higher the grade.	**5**
3.c.	Solution – Demonstrate that you have solved the problem through robot programming and part design.	**25**
	Total marks for Task 3	**40**

Appendix

Robot Dimensions -
https://emanual.robotis.com/docs/en/platform/openmanipulator_x/specification/