ASSUMPTION UNIVERSITY

VINCENT MARY SCHOOL OF ENGINEERING

FINAL EXAMINATION 1 / 2020 (Part 1)

SUBJECT : **MCE4101-Introduction to Robotics**

LECTURER : **Asst. Prof. Dr. Narong Aphiratsakun (narongphr@au.edu)**

DATE :

TIME : **1.30 Hr**

NAME ……	**SURNAME ……**	**ID.NO. ……**	**SEC……**

Make sure you have all the questions.

- Total examination paper: **1** question, **1** page (not including cover page).

Instructions:

1. This examination is worth a total of **80** points. This examination will contribute to **28% of your final grade**.
2. **Open books Examination**.
3. Answer in the provided booklet.
4. **Any** calculator can be used.
5. The University's examination regulations are on the reverse page. Students are expected to read and strictly observe them while the examination is in progress. Failure to do so would subject students to the terms of punishments.

This is to inform that

- Students are NOT allowed to use Smart Watches in examinations. Should they be brought into examination rooms, they are required to be placed on the floor under students' desk or chair.
- Violators will be subjected to the terms of punishment for violating examination regulations and/or cheating in the examination.

Other pertinent University's examination regulations are on the reverse page.
Students are expected to read and strictly observe them while the examination is in progress.
Failure to do so would subject students to the terms of punishments for violating examination regulations and/or cheating in the examination.

NAME ……. SURNAME ……. ID.NO. …… SEC……

1. (90 minutes). The 3 links RPP robot with 1DOF wrist name as iVMErobot is shown in Figure 1.
   a) (20 Marks) Obtain DH table and the transformation matrix **equation** T^0_{end}. Where d_1 and d_3 are robot links' offset and d_5 is 1DOF wrists' offset. Given $d_1 = 2$ and $d_3 = 1.5$ and $d_5 = 0.5$.
   b) (10 Marks) Obtain the transformation matrix **value** T^0_{end} when $\theta_1^* = 0°, d_2^* = 3, d_4^* = 1.5, \theta_4^* = 0°$.
   c) (5 Marks) Obtain the P_{end} when $\theta_1^* = 0°, d_2^* = 3, d_4^* = 1.5, \theta_4^* = 0°$.
   d) (10 Marks) Determine with **analytic method** for one set of possible solutions of end point location **Pend1 = [2.6 -1.5 4.5]**. Show your working steps.
   Data for Transformation matrix T0_3 as:

```
T03_values =

    0.5000    0.8660    0.0000    2.5981
    0.8660   -0.5000   -0.0000   -1.5000
         0    0.0000   -1.0000    5.0000
         0         0         0    1.0000
```

   Data for Transformation matrix T0_end as:

```
T04_values =

    0.5000    0.8660    0.0000    2.5981
    0.8660   -0.5000   -0.0000   -1.5000
         0    0.0000   -1.0000    4.5000
         0         0         0    1.0000
```

   e) (5 Marks) Determine with **ikine robotic function** for one set of possible solutions of end point location **Pend1 = [2.6 -1.5 4.5]**. Given IG = [pi/10 0.5 1 0]. Show your MATLAB code and the required variables.

   f) (10 Marks) Determine with **analytic method** for one set of possible solutions of end point location **Pend2 = [-1.5 -2.6 3.5]**. Show your working steps.
   Data for Transformation matrix T0_3 as:

```
T03_values =

    0.8660   -0.5000   -0.0000   -1.5000
   -0.5000   -0.8660   -0.0000   -2.5981
         0    0.0000   -1.0000    4.0000
         0         0         0    1.0000
```

   Data for Transformation matrix T0_end as:

```
T04_values =

    0.8660   -0.5000   -0.0000   -1.5000
   -0.5000   -0.8660   -0.0000   -2.5981
         0    0.0000   -1.0000    3.5000
         0         0         0    1.0000
```

   g) (5 Marks) Determine with **ikine robotic function** for one set of possible solutions of end point location **Pend2 = [-1.5 -2.6 3.5]**. Given IG = [-pi/10 0.5 1 0]. Show your MATLAB code and the required variables.

   h) (15 marks) From Pend1 to Pend2, obtain the required polynomial trajectories, velocities and accelerations **equations** for required joints to move from Pend1 to Pend2 within 4s (start at 0s, end at 4s). Initial and final velocity both are 0°/s. (Initial and final acceleration is not concerned).

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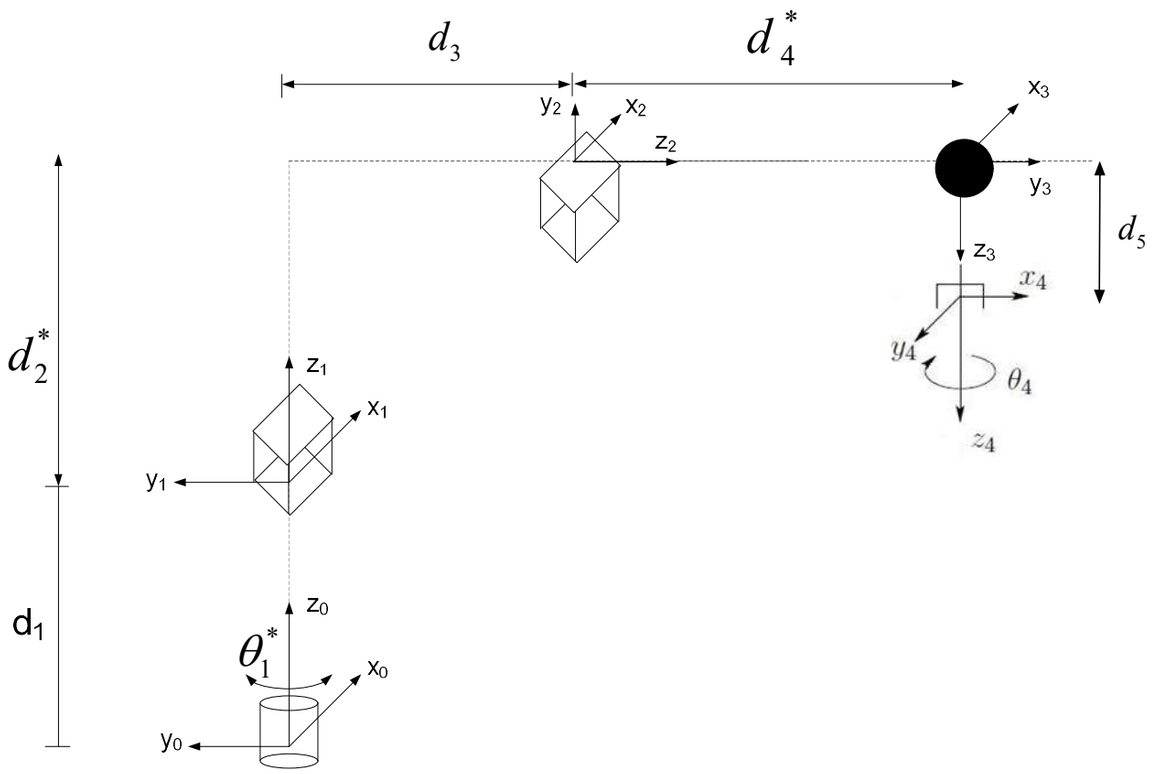

Figure 1: iVMErobot, RPP Robot with 1DOF wrist.

Total 80 Marks

%%%%%%%%%%%%%%%%%%Enjoy Robotics, End of Questions1%%%%%%%%%%%%%%%%%%