ASSUMPTION UNIVERSITY

VINCENT MARY SCHOOL OF ENGINEERING

FINAL EXAMINATION 1 / 2020 (Part 1)-SET3

SUBJECT : **MCE4101-Introduction to Robotics**

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

DATE :

TIME : **0.5 Hr**

NAME ...Todsavad.....	**SURNAME** .....Tangtortan.....	**ID.NO.** 6114215	**SEC.** 641..

Make sure you have all the questions.

- Total examination paper: **1** question, **2** pages (not including cover page).

Instructions:

1. This examination is worth a total of **50** points. This examination will contribute to **11.8% of your final grade**.
2. **Open books Examination**.
3. **Any** calculator can be used.
4. 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 .....Todsavad..... **SURNAME** .....Tangtortan..... **ID.NO.** 6114215 **SEC.** 641..

1. (50 minutes). Consider the trajectories shown in Figure 1.1.

   i. The robot travels from P0 (0°) to P1 (20°) in 2s. Velocity is start from rest 0°/s, and velocity is maintained 5.5°/s at P1 (20°).

   ii. The robot travels from P1 (20°) to P2 (60°) in another 2s. Velocity is start from 5.5°/s at P1 (20°), and velocity is come to 0°/s at P2 (60°).

   iii. The robot travels from P2 (60°) to P3 (0°) in another 2s. Velocity is start from 0°/s at P2 (60°), and velocity is come to 0°/s at P3 (0°).

Note 1: Trajectories, a velocity and acceleration graphs are given in Figure 1.2.

Determine the required polynomial **trajectories, velocities and accelerations equations** for the given path.

Note 2: There should be 3 set of equations for P0 (0°) to P1 (20°), P1 (20°) to P2 (60°) and P2 (60°) to P3 (0°). Each set there are 3 equations (q(t), v(t) and a(t)).

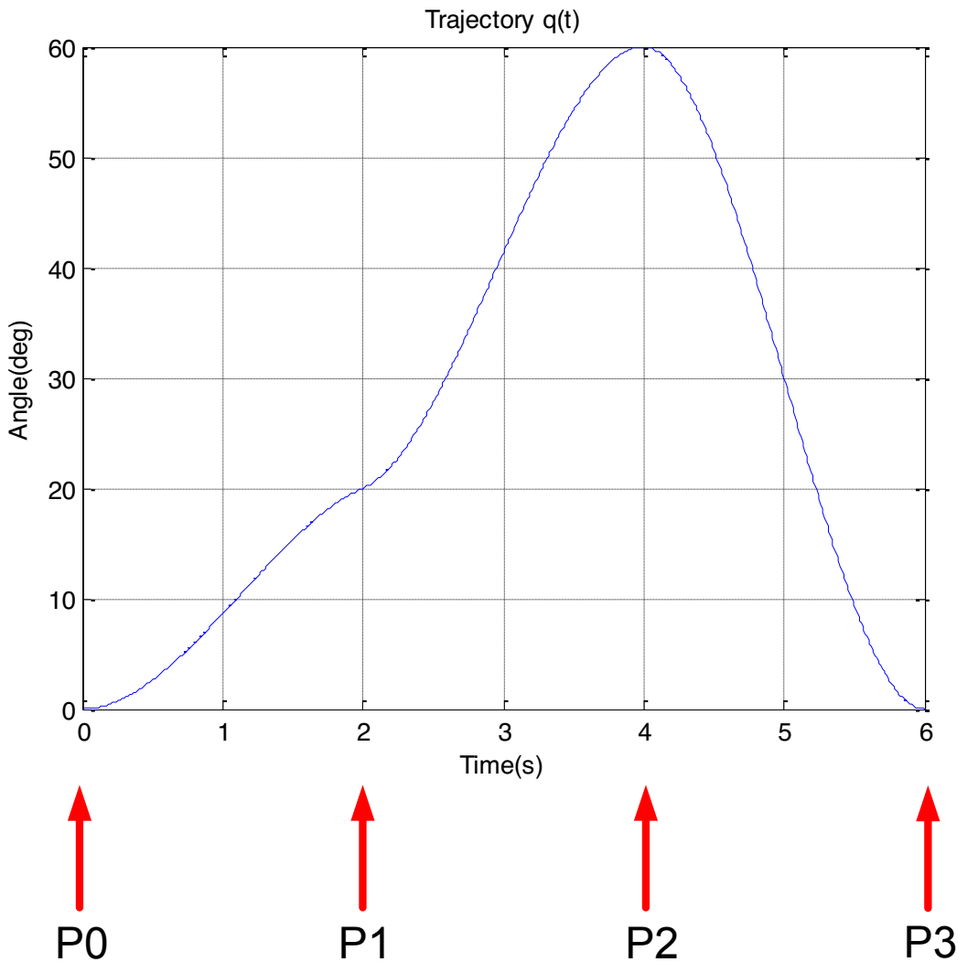

Figure 1.1: The trajectories from P0 to P1, P1 to P2 and P2 to P3.

NAME ....Tadsarad..... SURNAME .....Tangtortan..... ID.NO. .6114215 SEC..641.

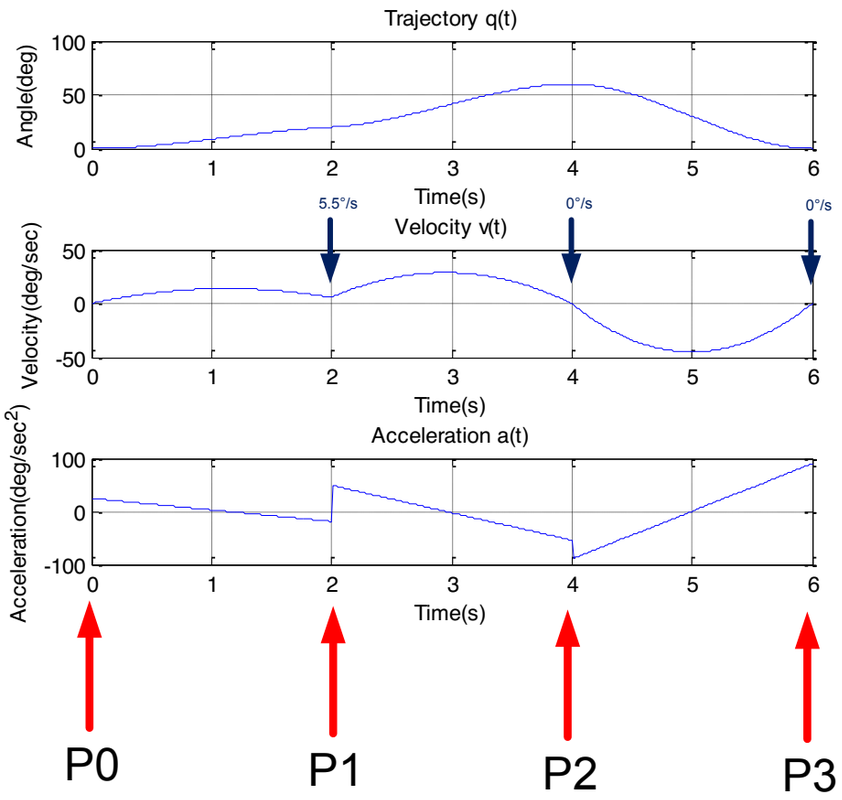

Figure 1.2: The trajectories, velocity and acceleration from P0 to P1, P1 to P2 and P2 to P3.

$A = [0; 0; 42.25; -13.625]$

Total 50 Marks

$B = [20; 5.5; 24.5; -8.625]$

$C = [60; 0; -45; 15]$

$q_1 = 42.25t^2 - 13.625t^3$
$v_1 = 84.45t - 40.875t^2$
$a_1 = 84.45 - 81.75t$

$q_2 = 20 + 5.5t + 24.5t^2 - 8.625t^3$
$v_2 = 5.5 + 49t - 25.875t^2$
$a_2 = 49 - 51.75t$

$q_3 = 60 - 45t^2 + 15t^3$
$v_3 = -90t + 45t^2$
$a_3 = -90 + 90t$

Code

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

```
%Final Q1
clear all; clc;
%Path Equation
%%Joint 1 cubic
q1_0 = 0
q1_f = 60;
v1_0 = 0;
v1_f = 5.5;
t0 = 0; tf = 2;
Y1 = [q1_0;v1_0;q1_f;v1_f];
B1 = [1 t0 t0^2 t0^3; 0 1 2*t0 3*t0^2; 1 tf tf^2 tf^3; 0 1 2*tf 3*tf^2];
%A1 = [a1_0;a1_1;a1_2;a1_3];
A1 = inv(B1)*Y1
%Joint 2
q2_0 = 20;
q2_f = 60;
v2_0 = 5.5;
v2_f = 0;
Y2 = [q2_0;v2_0;q2_f;v2_f];
B2 = [1 t0 t0^2 t0^3; 0 1 2*t0 3*t0^2; 1 tf tf^2 tf^3; 0 1 2*tf 3*tf^2];
A2 = inv(B2)*Y2
%Joint 3
q3_0 = 60;
q3_f = 0;
v3_0 = 0;
v3_f = 0;
Y3 = [q3_0;v3_0;q3_f;v3_f];
B3 = [1 t0 t0^2 t0^3; 0 1 2*t0 3*t0^2; 1 tf tf^2 tf^3; 0 1 2*tf 3*tf^2];
A3 = inv(B3)*Y3
```

```
%%Joint 1 trajectory equations
for i = 1:2 %10 datas
t(i) = i/10;
q1(i) = (42.25*t(i)^2) - (13.625*t(i)^3);
v1(i) = 84.45*t(i) - 40.875*t(i)^2
at1(i) = 84.45 - 81.75*t(i)
end


%%Joint 2 trajectory equations
for ii = 1:2 %10 datas
t(ii) = ii/10;
q2(ii) = 20 + 5.5*t(ii) + 24.5*t(ii)^2 - 8.625*t(ii)^3;
v2(ii) = 5.5 + 49*t(ii)- 25.875*t(ii)^2
at2(ii) = 49 - 51.75*t(ii)
end

%%Joint 3 trajectory equations
for iii = 1:2 %10 datas
t(iii) = iii/10;
q3(iii) = 60 - 45*t(iii)^2 + 15*t(iii)^3;
v3(iii) = -90*t(iii) + 45*t(iii)^2
at3(iii) = -90 + 90*t(iii)
end
```

```
v1 =

    8.0363

at1 =

   76.2750

v1 =

    8.0363   15.2550

at1 =

   76.2750   68.1000
```