THE UNIVERSITY OF TEXAS AT ARLINGTON, TEXAS
DEPARTMENT OF ELECTRICAL ENGINEERING

EE 5329

Distributed Decision and Control

TAKE HOME EXAM 1

by

SOUTRIK PRASAD MAITI

1001569883

Presented to

Dr. Frank Lewis

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EE 5329 Distributed Decision and Control

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Exam Pledge of Honor

On all exams in this class - YOU MUST WORK ALONE.

Any cheating or collusion will be severely punished.

It is very easy to compare your software code and determine if you worked together

It does not matter if you change the variable names.

Please sign this form and include it as the first page of all of your submitted homeworks.

.....
.....

Typed Name: Soutrik Maiti

Pledge of honor:

"On my honor I have neither given nor received aid on this homework."

e-Signature: Soutrik Maiti

MATLAB CODE:

Formation control function-

```
function Zdot = formationcontrol(t,z)
%% Adjacency Matrix of the formation graph

a = [0 0 0.5 0;
     0.5 0 0 0;
     0.5 0.5 0 0;
     0 0.5 0 0;];

 d = diag(sum(a,2));
 %% Graph Laplacian Matrix

 l = (d - a);
 %% Offset of the agents wrt leader
 del0 = [1 1];
 del1 = [1 -1];
 del2 = [-1 -1];
 del3 = [-1 1];

 del = [del0'; zeros(1,2)';del1'; zeros(1,2)';del2'
;zeros(1,2)';del3'; zeros(1,2)'];

 %% Setting the value of gamma
 gamma = 3;
 %% Pinning Gain Matrix
 G = [0 0 0 0;0 0.5 0 0;0 0 0 0;0 0 0 0];

 %% PD Gain Matrices
 kp = eye(2);
 kd = gamma*eye(2);
 K = [kp kd];

 c = 550;
 %% Agent Node Dynamics Matrices
 aSys = [zeros(2) eye(2);
         zeros(2) zeros(2)];
 bSys = [zeros(2); eye(2)];

 %% Kronecker Products
 kron1 = kron(eye(4),aSys);
 cL = c*(l + G);
 BK = bSys*K;
 kron2 = kron(cL,BK);
 Ac = kron1-kron2;

 %% Leader Dynamics
 x0 = aSys * z(17:20);

 %% Node Dynamics equation
```

```
 z0  = Ac*z(1:16) + kron2*del + kron2*([z(17:20); z(17:20); z(17:20);
z(17:20)]);
 Zdot = [z0;x0];

End
```

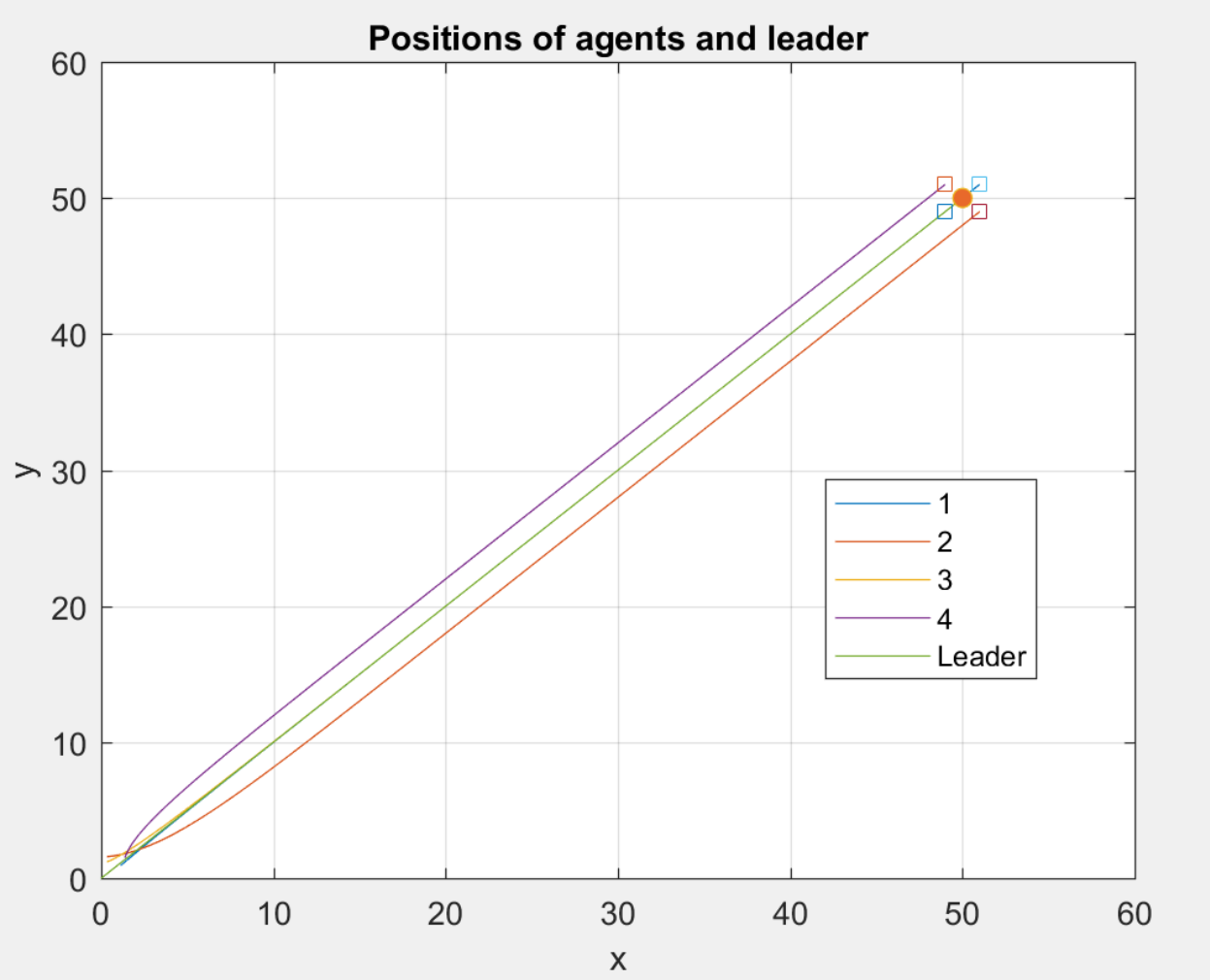
Simulation and calling the function-

```
clear all; clc;close all;


%% Simulating Dynamics for 4 agents and leader
[t,Zdot] =
ode23('formationcontrol',[0:0.01:50],[2*rand(8,1);2*rand(8,1);zeros(2,
1);ones(2,1)]);

%% Positions of the agents and leader
figure;
plot(Zdot(:,1),Zdot(:,2))       %agent1
hold on
plot(Zdot(:,5),Zdot(:,6))       %agent2
plot(Zdot(:,9),Zdot(:,10))      %agent3
plot(Zdot(:,13),Zdot(:,14))     %agent4
plot(Zdot(:,17),Zdot(:,18))     %Leader


grid on;
title('Positions of agents and leader')
xlabel('x');ylabel('y');

p1 = plot(Zdot(:,1),Zdot(:,2),'s');
p2 = plot(Zdot(:,5),Zdot(:,6),'s');
p3 = plot(Zdot(:,9),Zdot(:,10),'s');
p4 = plot(Zdot(:,13),Zdot(:,14),'s');
p = plot(Zdot(:,17),Zdot(:,18),'o','MarkerFaceColor',[0.91 0.41
0.17]);
legend('1','2','3','4','Leader')
hold off
%% Plot Animations
for k = 1:size(t,1)
 p1.XData = Zdot(k,1);
 p1.YData = Zdot(k,2);
 p2.XData = Zdot(k,5);
 p2.YData = Zdot(k,6);
 p3.XData = Zdot(k,9);
 p3.YData = Zdot(k,10);
 p4.XData = Zdot(k,13);
 p4.YData = Zdot(k,14);
 p.XData = Zdot(k,17);
 p.YData = Zdot(k,18);
```

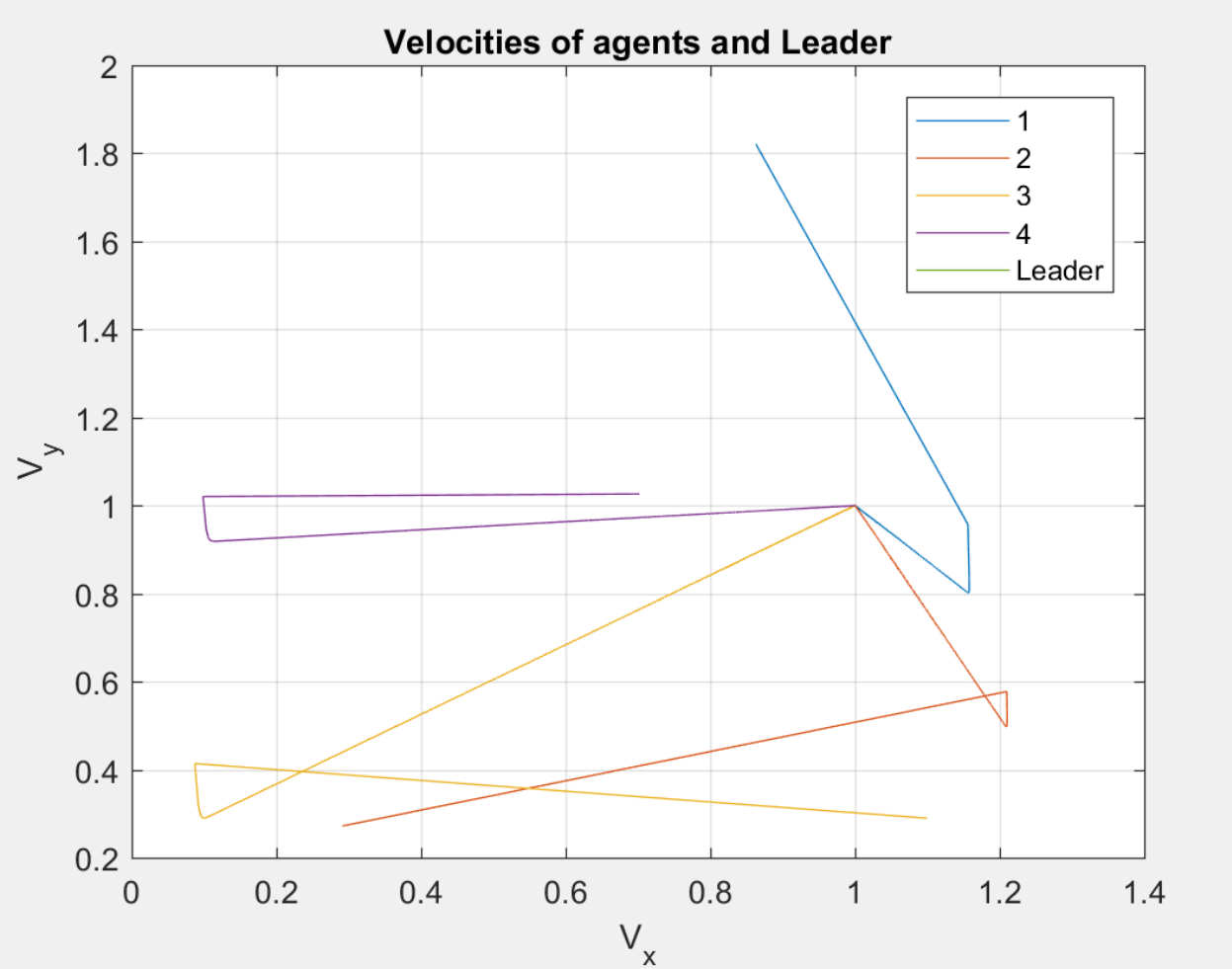
```
 drawnow limitrate

end
drawnow
%% Velocities of agents and leader
figure;
plot(Zdot(:,3),Zdot(:,4))        %agent1
hold on
plot(Zdot(:,7),Zdot(:,8))        %agent2
plot(Zdot(:,11),Zdot(:,12))      %agent3
plot(Zdot(:,15),Zdot(:,16))      %agent4
plot(Zdot(:,19),Zdot(:,20))      %Leader
legend('1','2','3','4','Leader')
grid on;
title('Velocities of agents and Leader')
xlabel('V_x');ylabel('V_y');
```

RESULTS:

The following figure shows the position of agents and the leader.



The following figure shows the velocities of agents and Leader.



Thus, from the above two figures we can see that the agents finally reach consensus with leader.