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

EE 5329

Distributed Decision and Control

HW # 6
ASSIGNMENT

by

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Presented to

Dr. Frank Lewis

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EE 5329 Distributed Decision and Control

Spring 2018

Homework Pledge of Honor

On all homeworks 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."

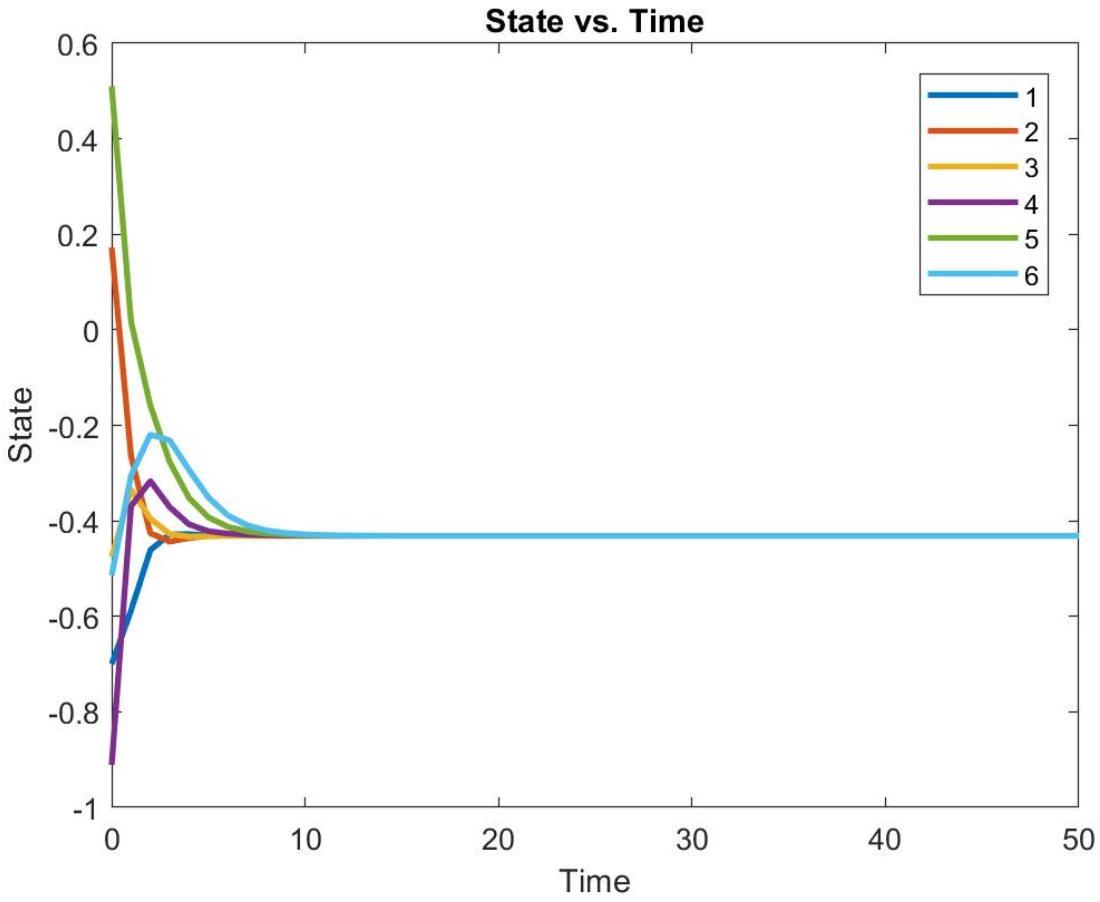
e-Signature: Soutrik Maiti

Problem 1:

a) MATLAB CODE:

```
clear all;
close all;

%% Adjacency Matrix for the given problem
a = [0 0 1 0 0 0;
    1 0 0 0 0 0;
    1 1 0 0 0 0;
    0 1 0 0 0 0;
    0 0 1 0 0 0;
    0 0 0 1 1 0];

%% In degree matrix

d =
diag([sum(a(1,:));sum(a(2,:));sum(a(3,:));sum(a(4,:));sum(a(5,:));sum(
a(6,:))]);


%% Random initial values

x = (2)*rand(1,6)-1;

for k = 1:50

x(k+1,:) = (inv(eye(6)+d))*(eye(6)+a)*x(k,:)';
end

%% Plotting State vs time
figure
plot(0:50,x,'linewidth',2)
legend('1','2','3','4','5','6')
title('State vs. Time')
xlabel('Time');
ylabel('State');
```

Result:

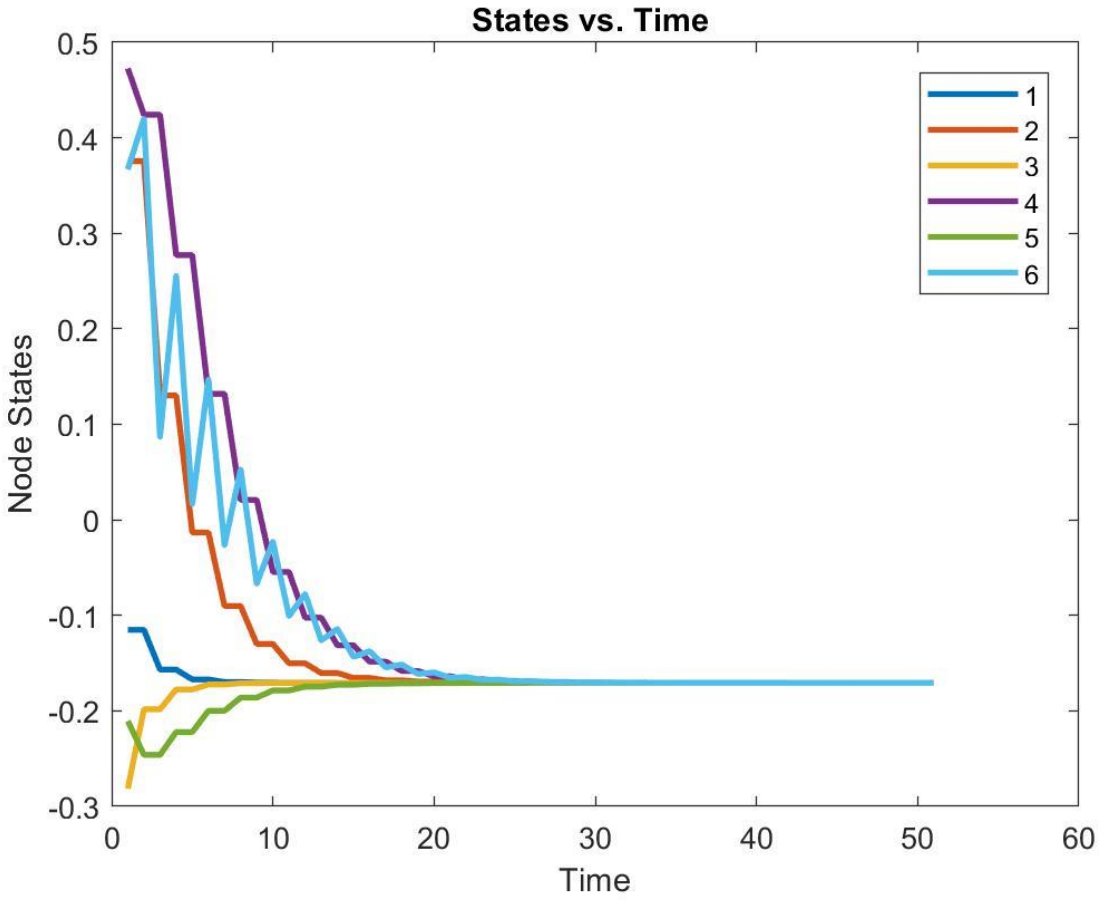


b) MATLAB CODE:

```
clear all;
close all;
clc;
%% Adjacency Matrix for the given problem
a1 = [0 0 0 0 0 0;
    0 0 0 0 0 0;
    1 0 0 0 0 0;
    0 1 0 0 0 0;
    0 0 1 0 0 0;
    0 0 0 1 0 0];
a2 = [0 0 1 0 0 0;
    1 0 0 0 0 0;
    0 0 0 0 0 0;
    0 0 0 0 0 0;
    0 0 0 0 0 0;
    0 0 0 0 1 0];
```

```
a3 = [0 0 0 0 0 0;
    0 0 0 0 0 1;
    0 1 0 0 0 0;
    0 1 0 0 0 0;
    0 0 0 0 0 0;
    0 0 0 0 0 0];

ak(:,:,1) = a1;
ak(:,:,2) = a2;
ak(:,:,3) = a3;
%% In degree matrix
d1 =
diag([sum(a1(1,:));sum(a1(2,:));sum(a1(3,:));sum(a1(4,:));sum(a1(5,:))
;sum(a1(6,:))]);
d2 =
diag([sum(a2(1,:));sum(a2(2,:));sum(a2(3,:));sum(a2(4,:));sum(a2(5,:))
;sum(a2(6,:))]);
d3 =
diag([sum(a3(1,:));sum(a3(2,:));sum(a3(3,:));sum(a3(4,:));sum(a3(5,:))
;sum(a3(6,:))]);

dk(:,:,1) = d1;
dk(:,:,2) = d2;
dk(:,:,3) = d3;
%% Random initial values
x = (2)*rand(1,6)-1;

x1 =x;

j =1;
for k = 1:50
   fk(:,:,j) = (inv(eye(6)+dk(:,:,j)))*(eye(6)+ ak(:,:,j));
    x1(k+1,:) = fk(:,:,j)*x1(k,:)';
    j = j+1;
    if j == 3
        j = 1;
    end
end

%% Plotting states vs. time
figure;
plot (1:51,x1,'LineWidth',2)
legend('1','2','3','4','5','6')
title('States vs. Time ')
xlabel('Time');ylabel('Node States');
```

Result:



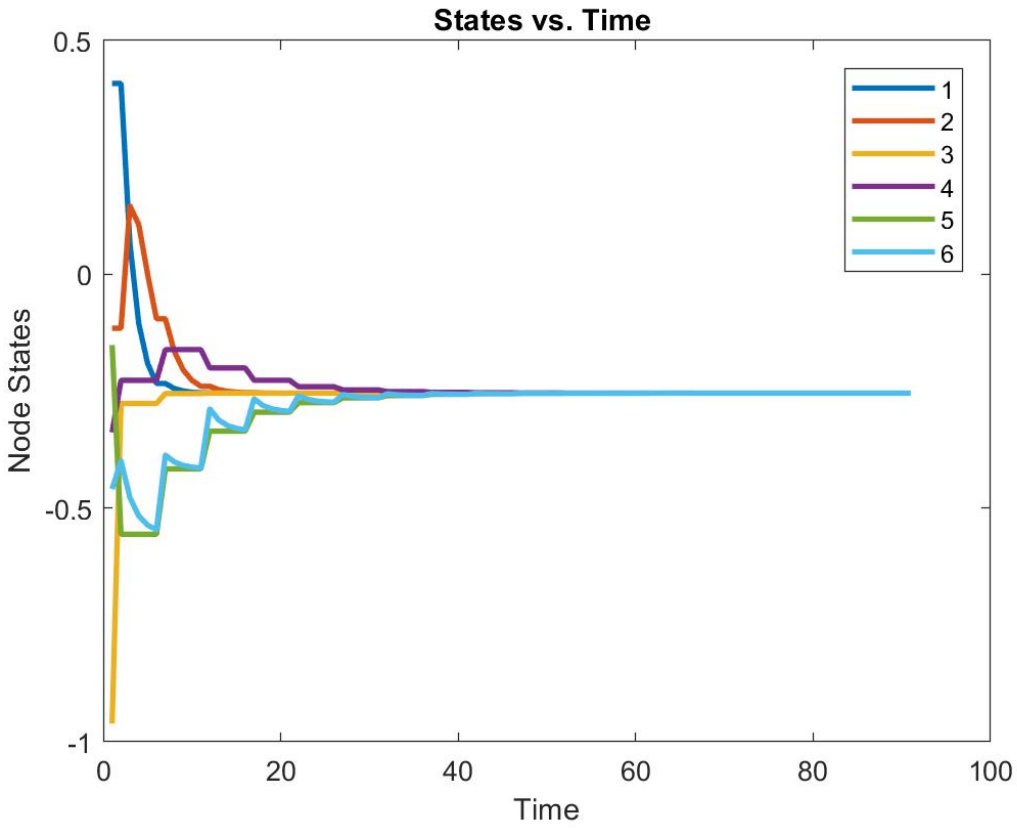
The consensus is reached, but it occurs later than the complete graph. Also, the consensus values are different than the consensus value of compete graph.

c) MATLAB CODE:

```
clear all;
close all;
clc;
%% Adjacency Matrix for the given problem
a1 = [0 0 0 0 0 0;
    0 0 0 0 0 0;
    1 0 0 0 0 0;
    0 1 0 0 0 0;
    0 0 1 0 0 0;
    0 0 0 1 0 0];
a2 = [0 0 1 0 0 0;
    1 0 0 0 0 0;
    0 0 0 0 0 0;
    0 0 0 0 0 0;
    0 0 0 0 0 0;
    0 0 0 0 1 0];
a3 = [0 0 0 0 0 0;
    0 0 0 0 0 1;
    0 1 0 0 0 0;
    0 1 0 0 0 0;
    0 0 0 0 0 0;
    0 0 0 0 0 0];

ak(:,:,1) = a1;
ak(:,:,2) = a2;
ak(:,:,3) = a3;
%% In degree matrix
d1 =
diag([sum(a1(1,:));sum(a1(2,:));sum(a1(3,:));sum(a1(4,:));sum(a1(5,:))
;sum(a1(6,:))]);
d2 =
diag([sum(a2(1,:));sum(a2(2,:));sum(a2(3,:));sum(a2(4,:));sum(a2(5,:))
;sum(a2(6,:))]);
d3 =
diag([sum(a3(1,:));sum(a3(2,:));sum(a3(3,:));sum(a3(4,:));sum(a3(5,:))
;sum(a3(6,:))]);

dk(:,:,1) = d1;
dk(:,:,2) = d2;
dk(:,:,3) = d3;
%% Random initial values
x = (2)*rand(1,6)-1;
x2 = x;
j = 1;
cnt = 0;
%% For 12222233333 12222233333 cycle
for k = 1:90
    fk(:,:,j) = (inv(eye(6) + dk(:,:,j))) * (eye(6) + ak(:,:,j));
x2(k+1,:) = fk(:,:,j) *x2(k,:)';
```

```
if j == 1
    j = j+1;
    cnt = cnt +1;
else
if cnt == 5
j = j + 1;
cnt = 0;
end
cnt = cnt + 1;
if cnt == 5
j = 1;
cnt = 0;
end
end
end
%% Plotting states vs. time
figure;
plot (1:91,x2,'LineWidth',2)
legend('1','2','3','4','5','6')
title('States vs. Time ')
xlabel('Time');ylabel('Node States');
```

Result:



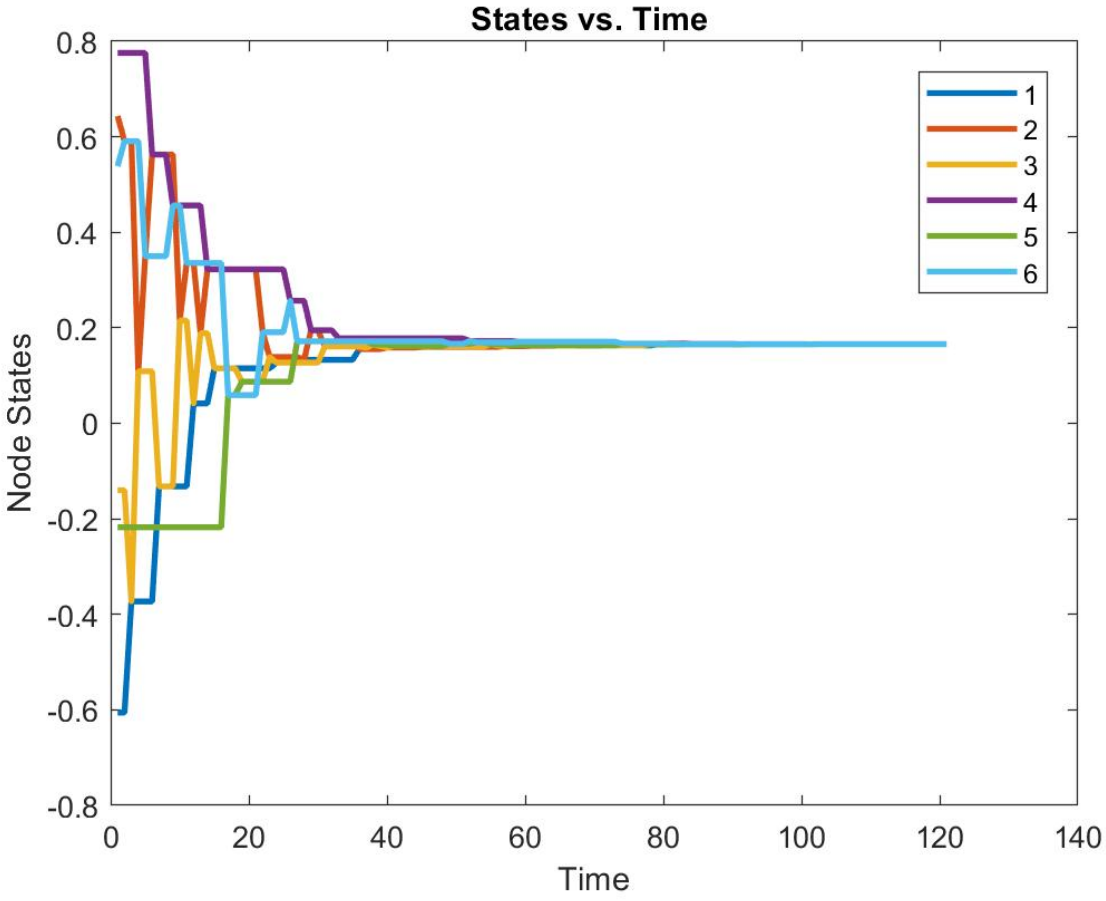
The consensus value of this specific cycle is different than the consensus value of the complete graph and the graph reaches consensus at a time later than that of the complete graph & part b as well. This is because of the Left Eigen vectors and the sequence in which the graphs are updated.

Problem 2:
MATLAB CODE-

```
clear all;
clc;
%% Random initial values
x3 = (2)*rand(1,6)-1;

for k = 1:120
    edge = randi(9); % Randomly chosing edges
if edge == 1
    x3(k+1,1) = x3(k,1) + (x3(k,2) - x3(k,1))/2;
    x3(k+1,2) = x3(k,2) - (x3(k,2) - x3(k,1))/2;
    x3(k+1,3) = x3(k,3);
    x3(k+1,4) = x3(k,4);
    x3(k+1,5) = x3(k,5);
    x3(k+1,6) = x3(k,6);
elseif edge == 2
    x3(k+1,2) = x3(k,2) + (x3(k,4) - x3(k,2))/2;
    x3(k+1,4) = x3(k,4) - (x3(k,4) - x3(k,2))/2;
    x3(k+1,1) = x3(k,1);
    x3(k+1,3) = x3(k,3);
    x3(k+1,5) = x3(k,5);
    x3(k+1,6) = x3(k,6);
elseif edge == 3
    x3(k+1,4) = x3(k,4) + (x3(k,6) - x3(k,4))/2;
    x3(k+1,6) = x3(k,6) - (x3(k,6) - x3(k,4))/2;
    x3(k+1,1) = x3(k,1);
    x3(k+1,2) = x3(k,2);
    x3(k+1,3) = x3(k,3);
    x3(k+1,5) = x3(k,5);
elseif edge == 4
    x3(k+1,6) = x3(k,6) + (x3(k,2) - x3(k,6))/2;
    x3(k+1,2) = x3(k,2) - (x3(k,2) - x3(k,6))/2;
    x3(k+1,3) = x3(k,3);
    x3(k+1,4) = x3(k,4);
    x3(k+1,5) = x3(k,5);
    x3(k+1,1) = x3(k,1);
elseif edge == 5
    x3(k+1,5) = x3(k,5) + (x3(k,6) - x3(k,5))/2;
    x3(k+1,6) = x3(k,6) - (x3(k,6) - x3(k,5))/2;
```

```
    x3(k+1,1) = x3(k,1);
    x3(k+1,2) = x3(k,2);
    x3(k+1,3) = x3(k,3);
    x3(k+1,4) = x3(k,4);
elseif edge == 6
    x3(k+1,3) = x3(k,3) + (x3(k,5) - x3(k,3))/2;
    x3(k+1,5) = x3(k,5) - (x3(k,5) - x3(k,3))/2;
    x3(k+1,1) = x3(k,1);
    x3(k+1,2) = x3(k,2);
    x3(k+1,4) = x3(k,4);
    x3(k+1,6) = x3(k,6);
elseif edge == 7
    x3(k+1,2) = x3(k,2) + (x3(k,3) - x3(k,2))/2;
    x3(k+1,3) = x3(k,3) - (x3(k,3) - x3(k,2))/2;
    x3(k+1,1) = x3(k,1);
    x3(k+1,4) = x3(k,4);
    x3(k+1,5) = x3(k,5);
    x3(k+1,6) = x3(k,6);
elseif edge == 8
    x3(k+1,1) = x3(k,1) + (x3(k,3) - x3(k,1))/2;
    x3(k+1,3) = x3(k,3) - (x3(k,3) - x3(k,1))/2;
    x3(k+1,2) = x3(k,2);
    x3(k+1,4) = x3(k,4);
    x3(k+1,5) = x3(k,5);
    x3(k+1,6) = x3(k,6);
elseif edge == 9
    x3(k+1,3) = x3(k,3) + (x3(k,1) - x3(k,3))/2;
    x3(k+1,1) = x3(k,1) - (x3(k,1) - x3(k,3))/2;
    x3(k+1,2) = x3(k,2);
    x3(k+1,4) = x3(k,4);
    x3(k+1,5) = x3(k,5);
    x3(k+1,6) = x3(k,6);

end
end

%% Plotting states vs. time
figure;
plot (1:121,x3,'LineWidth',2)
legend('1','2','3','4','5','6')
title('States vs. Time ')
xlabel('Time');ylabel('Node States');
```

Result:


States vs. Time
Node States
Time
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
20
40
60
80
100
120
140
1
2
3
4
5
6