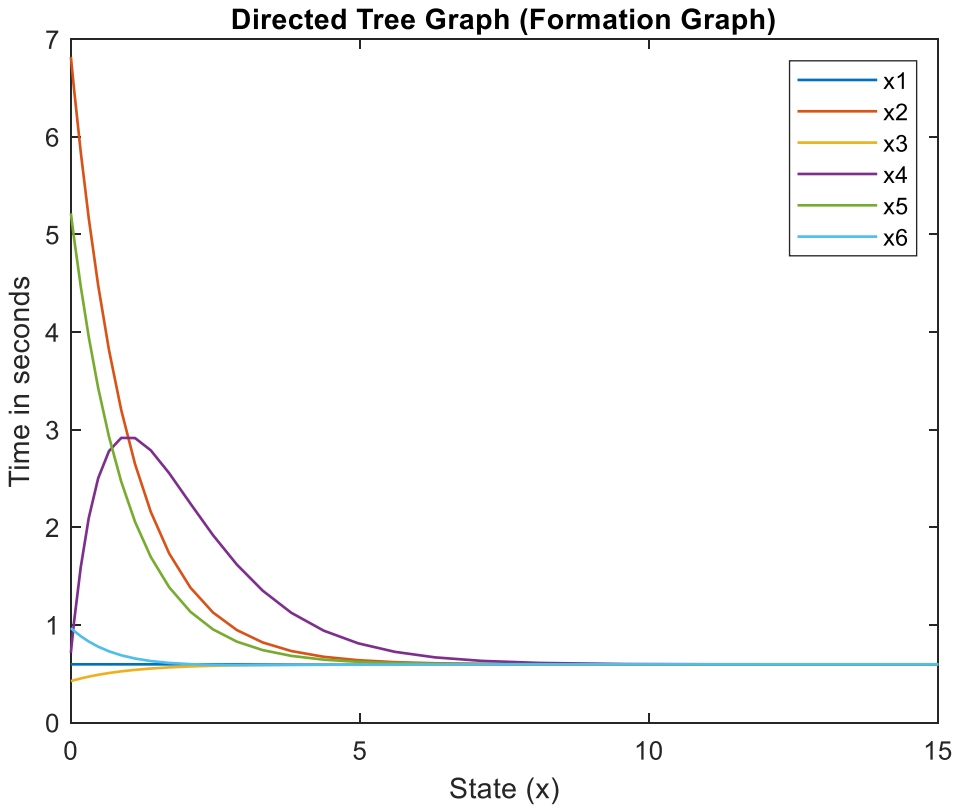
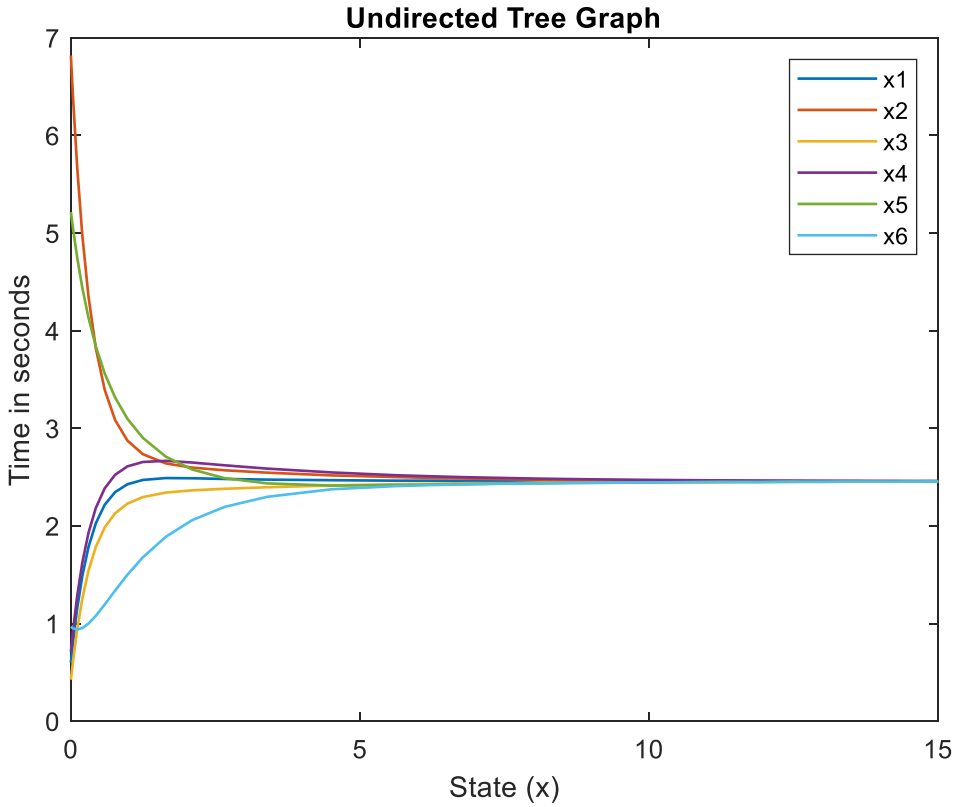
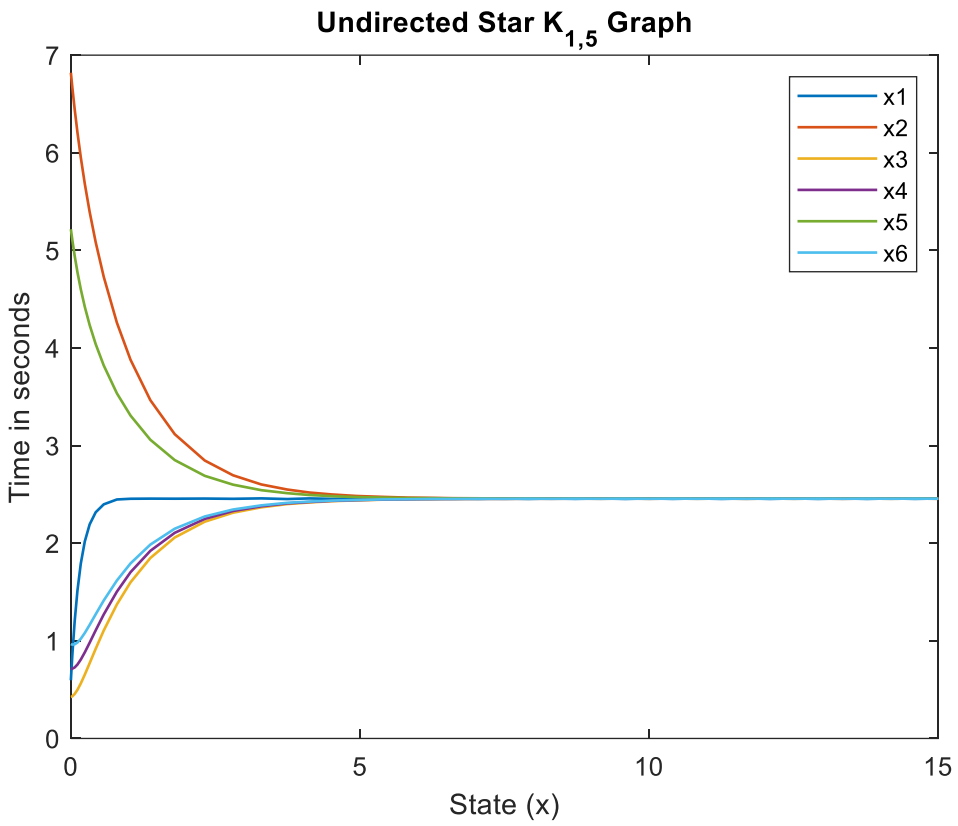
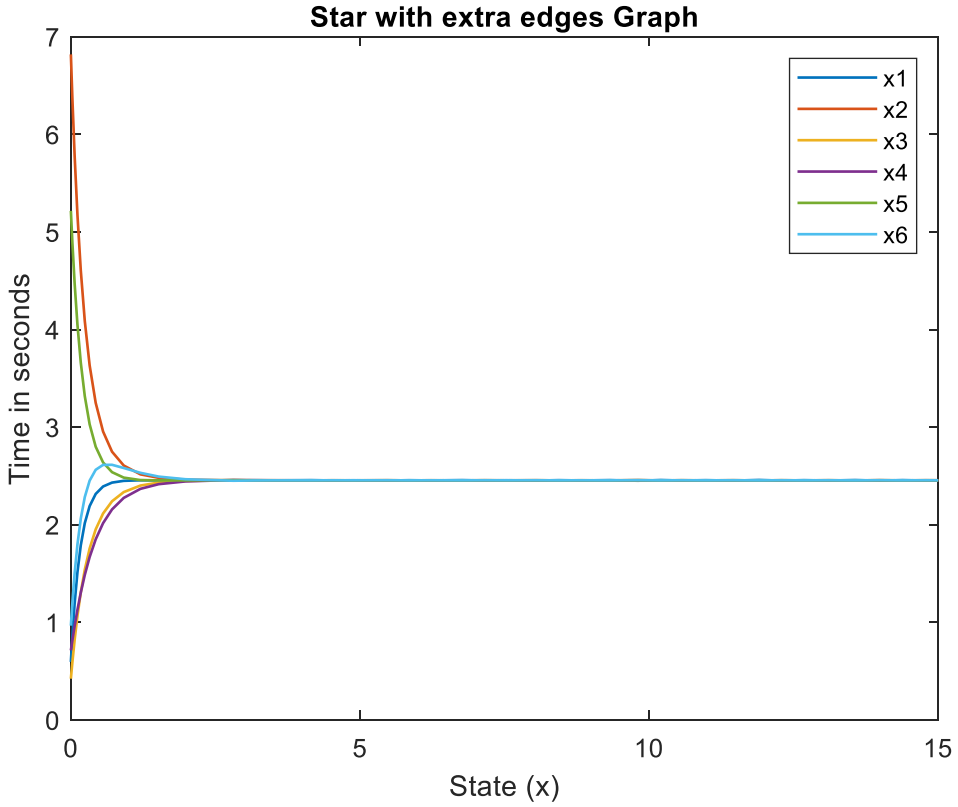
Convergence Plots

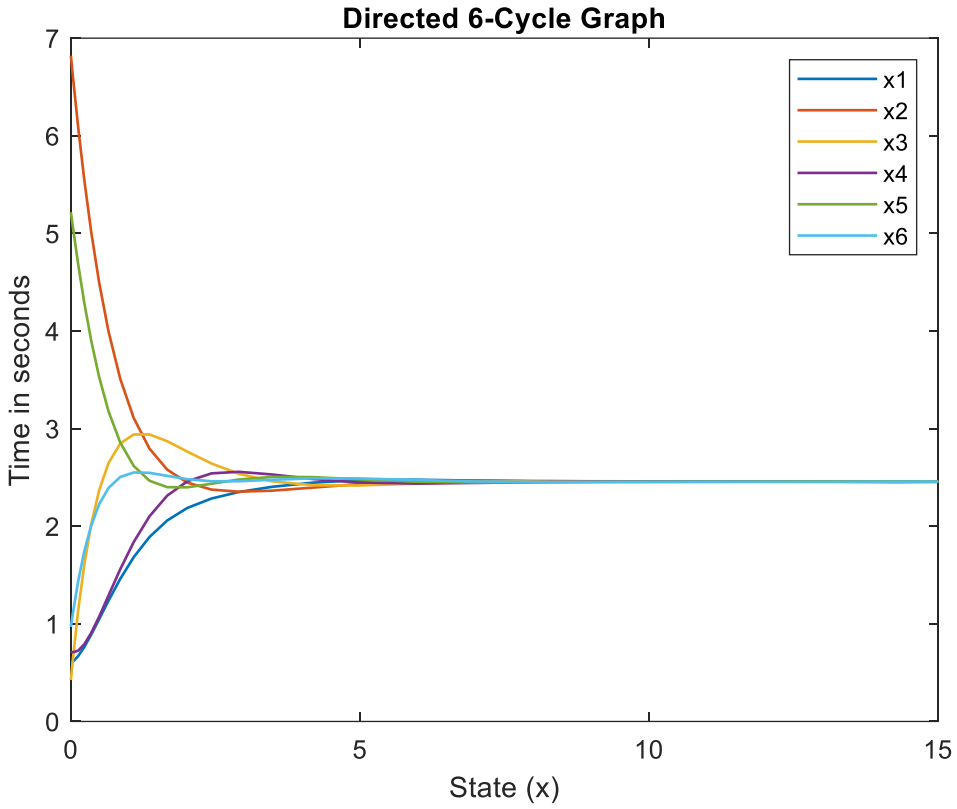
Note – All plots have been plotted using the same initial conditions to compare consensus convergence rates effectively.

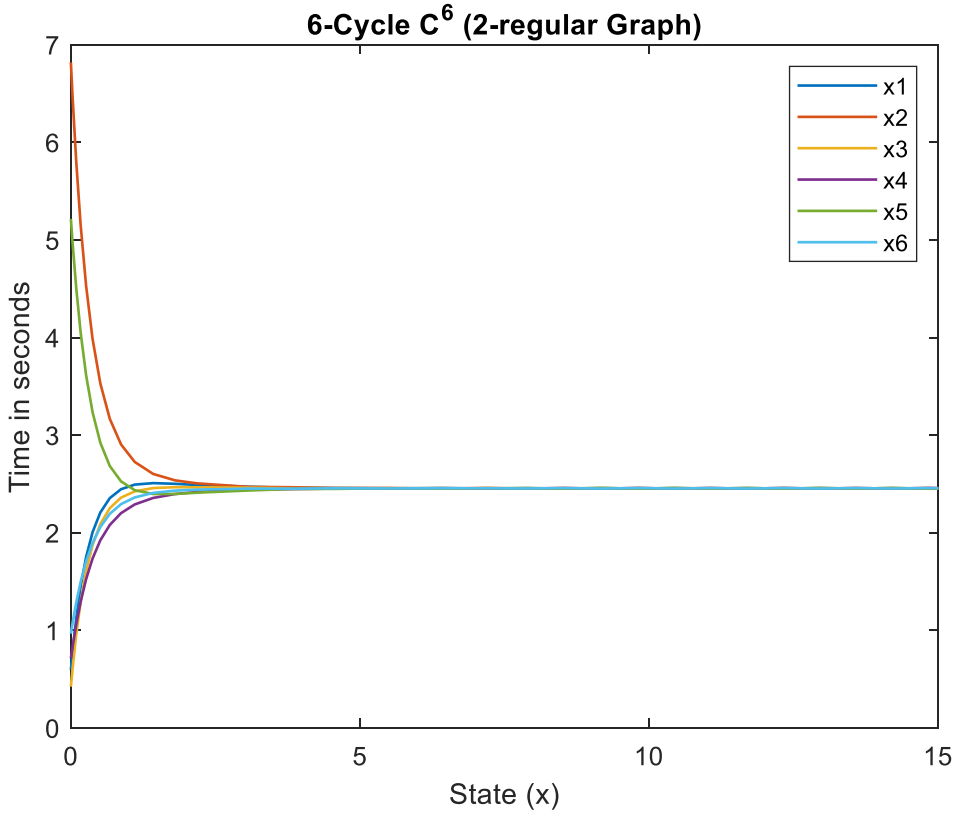


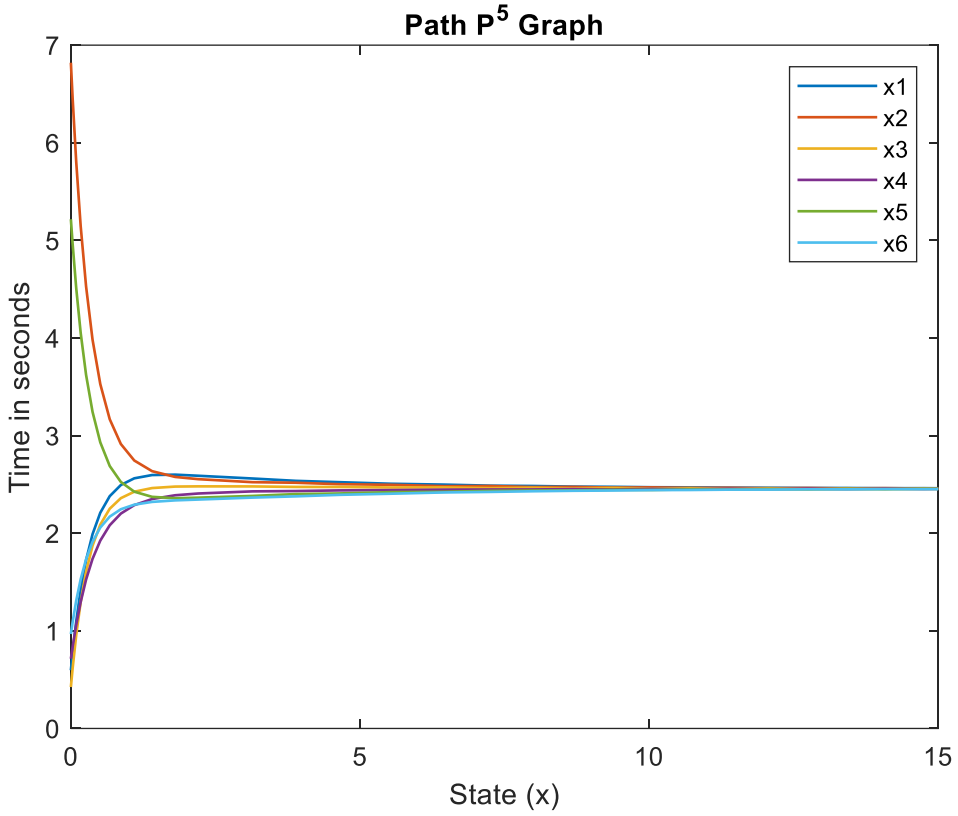



Undirected Star K1,5 Graph
Time in seconds
State (x)
x1
x2
x3
x4
x5
x6
0
1
2
3
4
5
6
7
0
5
10
15


Star with extra edges Graph
Time in seconds
State (x)
x1
x2
x3
x4
x5
x6
0
1
2
3
4
5
6
7
0
5
10
15


Directed 6-Cycle Graph
x1
x2
x3
x4
x5
x6
Time in seconds
State (x)
0
1
2
3
4
5
6
7
0
5
10
15


6-Cycle C6 (2-regular Graph)
x1
x2
x3
x4
x5
x6
Time in seconds
State (x)
0
1
2
3
4
5
6
7
0
5
10
15



MATLAB Code

```
function convergencecomparison
init=rand(1,6).*10;
tin=[0 15]; %time interval
A1=[0 0 0 0 0 0;1 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 1 0 0 0];
D1=[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 0 0 0 0 1];
L1=D1-A1;
[t,x]=ode23(@equations,tin,init);
function dx=equations(t,x)
 dx=zeros(6,1);
 dx(1:6)=-L1*x(1:6);
end
figure(1)
plot(t,x(:,1:6), 'LineWidth',1)
title('Directed Tree Graph (Formation Graph)')
xlabel('State (x)')
ylabel('Time in seconds')
legend({'x1','x2','x3','x4','x5','x6'})
```

```
%-------------------------------------------------------------------
------------
A2=[0 1 1 0 0 0;1 0 0 1 0 0;1 0 0 0 1 1;0 1 0 0 0 0;0 0 1 0 0
0;0 0 1 0 0 0];
D2=[2 0 0 0 0 0;0 2 0 0 0 0;0 0 3 0 0 0;0 0 0 1 0 0;0 0 0 0 1
0;0 0 0 0 0 1];
L2=D2-A2;
[tb,xb]=ode23(@equations2,tin,init);
function dxb=equations2(tb,xb)
 dxb=zeros(6,1);
 dxb(1:6)=-L2*xb(1:6);
end
figure(2)
plot(tb,xb(:,1:6), 'LineWidth',1)
title('Undirected Tree Graph')
xlabel('State (x)')
ylabel('Time in seconds')
legend({'x1','x2','x3','x4','x5','x6'})
%-------------------------------------------------------------------
------------
A3=[0 1 1 1 1 1;1 0 0 0 0 0;1 0 0 0 0 0;1 0 0 0 0 0;1 0 0 0 0
0;1 0 0 0 0 0];
D3=[5 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 0 0 0 0 1];
L3=D3-A3;
[tc,xc]=ode23(@equationsc,tin,init);
function dxc=equationsc(tc,xc)
 dxc=zeros(6,1);
 dxc(1:6)=-L3*xc(1:6);
end
figure(3)
plot(tc,xc(:,1:6), 'LineWidth',1)
title('Undirected Star K_1_,_5 Graph')
xlabel('State (x)')
ylabel('Time in seconds')
legend({'x1','x2','x3','x4','x5','x6'})
%-------------------------------------------------------------------
------------
A4=[0 1 1 1 1 1;1 0 1 0 0 1;1 1 0 1 0 0;1 0 1 0 1 0;1 0 0 1 0
1;1 1 0 0 1 0];
D4=[5 0 0 0 0 0;0 3 0 0 0 0;0 0 3 0 0 0;0 0 0 3 0 0;0 0 0 0 3
0;0 0 0 0 0 3];
L4=D4-A4;
[td,xd]=ode23(@equationsd,tin,init);
function dxd=equationsd(td,xd)
 dxd=zeros(6,1);
 dxd(1:6)=-L4*xd(1:6);
```

```
end
figure(4)
plot(td,xd(:,1:6), 'LineWidth',1)
title('Star with extra edges Graph')
xlabel('State (x)')
ylabel('Time in seconds')
legend({'x1','x2','x3','x4','x5','x6'})
%-------------------------------------------------------------
------------
A5=[0 0 0 0 0 1;1 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];
D5=[1 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 0 0 0 0 1];
L5=D5-A5;
[te,xe]=ode23(@equationse,tin,init);
function dxe=equationse(te,xe)
 dxe=zeros(6,1);
 dxe(1:6)=-L5*xe(1:6);
end
figure(5)
plot(te,xe(:,1:6), 'LineWidth',1)
title('Directed 6-Cycle Graph')
xlabel('State (x)')
ylabel('Time in seconds')
legend({'x1','x2','x3','x4','x5','x6'})
%-------------------------------------------------------------
------------
A6=[0 1 0 0 0 1;1 0 1 0 0 0;0 1 0 1 0 0;0 0 1 0 1 0;0 0 0 1 0
1;1 0 0 0 1 0];
D6=[2 0 0 0 0 0;0 2 0 0 0 0;0 0 2 0 0 0;0 0 0 2 0 0;0 0 0 0 2
0;0 0 0 0 0 2];
L6=D6-A6;
[tf,xf]=ode23(@equationsf,tin,init);
function dxf=equationsf(tf,xf)
 dxf=zeros(6,1);
 dxf(1:6)=-L6*xf(1:6);
end
figure(6)
plot(tf,xf(:,1:6), 'LineWidth',1)
title('6-Cycle C^6 (2-regular Graph)')
xlabel('State (x)')
ylabel('Time in seconds')
legend({'x1','x2','x3','x4','x5','x6'})
%-------------------------------------------------------------
------------
A7=[0 1 0 0 0 0;1 0 1 0 0 0;0 1 0 1 0 0;0 0 1 0 1 0;0 0 0 1 0
1;0 0 0 0 1 0];
```

```
D7=[1 0 0 0 0 0;0 2 0 0 0 0;0 0 2 0 0 0;0 0 0 2 0 0;0 0 0 0 2
0;0 0 0 0 0 1];
L7=D7-A7;
[tg,xg]=ode23(@equationsg,tin,init);
function dxg=equationsg(tg,xg)
 dxg=zeros(6,1);
 dxg(1:6)=-L7*xg(1:6);
end
figure(7)
plot(tg,xg(:,1:6), 'LineWidth',1)
title('Path P^5 Graph')
xlabel('State (x)')
ylabel('Time in seconds')
legend({'x1','x2','x3','x4','x5','x6'})
end
```