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AMATH 301 Section A
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Problem 1

a)

```
x1=0;
for i=1:25000000
    x1=x1+0.1;
end
x1

x2=0;
for i=1:12500000
    x2=x2+0.2;
end
x2

x3=0;
for i=1:10000000
    x3=x3+0.25;
end
x3

x4=0;
for i=1:5000000
    x4=x4+0.5;
end
x4
```

b)

```
y1=abs(2500000-x1)
y2=abs(2500000-x2)
y3=abs(2500000-x3)
y4=abs(2500000-x4)
```

c) y1 is larger than y2 where y1-y2= 0.001148897223175. This is because the values for x1 and x2 are not the same, which can be seen in the workspace. When performing loops with many iterations such as the loops used to calculate x1 and x2, the return value of the loop will contain some degree of error due to the fact that matlab cannot store binary floating point numbers.

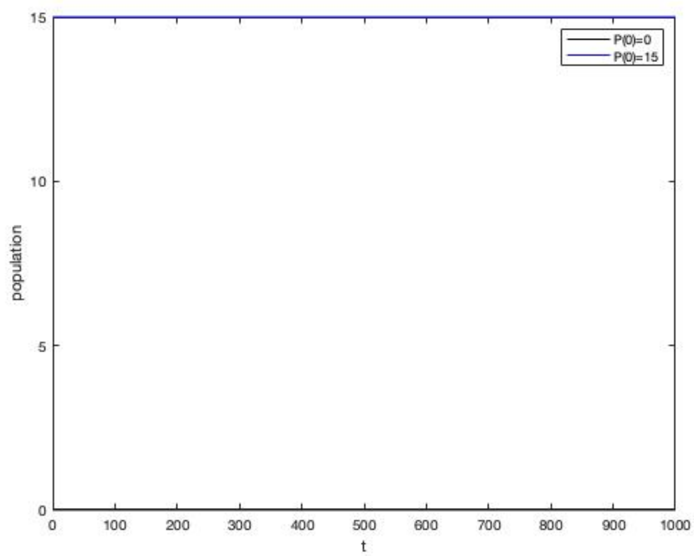
d) y3 and y4 are exactly zero, but y1 and y2 are not.

e)The y values that are exactly zero are exactly zero because their corresponding x3 and x4 values are exactly 2500000. Matlab stores binary numbers and 0.5 and 0.25 can be stored as binary numbers 0.1 and 0.01, whereas 0.2 and 0.1 cannot be stored as binary numbers, so they contain some degree of error when used in calculations.

Problem 2

a)

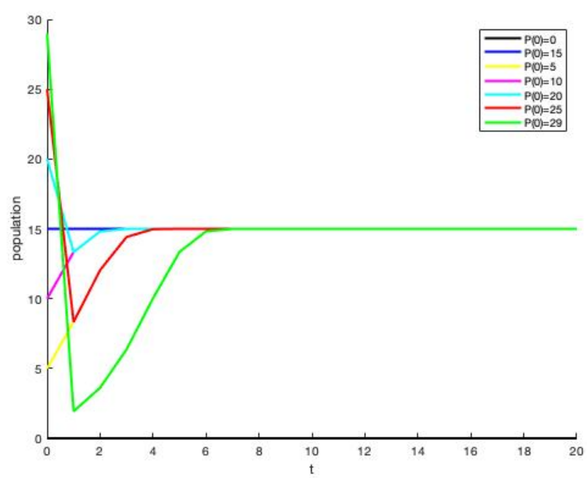
```
a=P(0,1000,2,30);
b=P(15,1000,2,30);
t=0:1000;
plot(t,a,'k',t,b,'b')
xlabel('t')
ylabel('population')
legend('P(0)=0','P(0)=15')

function pop=P(P0,T,r,K)
    pop=zeros(1,T+1);
    pop(1)=P0;
    for t=2:T+1
        pop(t)=r*pop(t-1)*(1-pop(t-1)/K);
    end
end
```



Given the definition of equilibrium, these graphs make sense. Each solution for P has initial conditions of P(0)=steady state and so P(t) will remain at this steady state (since once P(t)=steady state, it will remain at that value for all future times) , hence the solutions graphs being horizontal lines.

b)

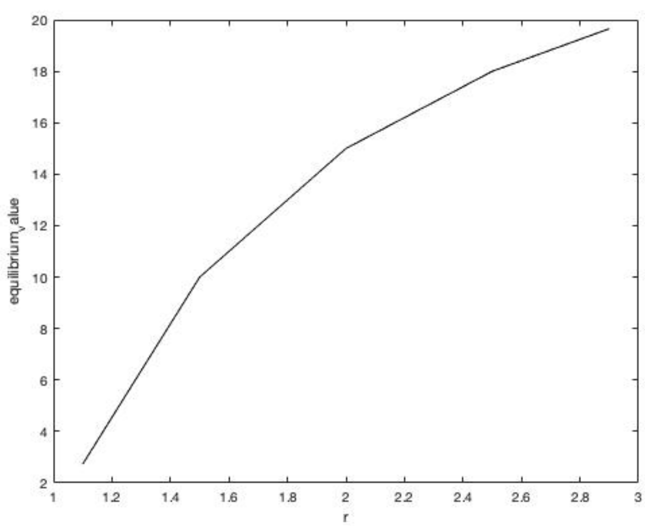
```
clear all; close all;clc
a=P(0,20,2,30);
b=P(15,20,2,30);
c=P(5,20,2,30);
d=P(10,20,2,30);
e=P(20,20,2,30);
f=P(25,20,2,30);
g=P(29,20,2,30);


t=0:20;
hold on
plot(t,a,'k','LineWidth',2)
plot(t,b,'b','LineWidth',2)
plot(t,c,'y','LineWidth',2)
plot(t,d,'m','LineWidth',2)
plot(t,e,'c','LineWidth',2)
plot(t,f,'r','LineWidth',2)
plot(t,g,'g','LineWidth',2)
hold off

xlabel('t')
ylabel('population')
legend('P(0)=0','P(0)=15','P(0)=5','P(0)=10','P(0)=20','P(0)=25','P(0)=29')

function pop=P(P0,T,r,K)
    pop=zeros(1,T+1);
    pop(1)=P0;
    for t=2:T+1
        pop(t)=r*pop(t-1)*(1-pop(t-1)/K);
    end
end
```



The equilibrium P2*=15 is stable, as all of the solutions to P with different starting values (shown in the legend) tend towards the solution for P where P(0)=P2*=15; all solutions tend towards P(t)=15. The equilibrium P1*=0 is unstable because all of the solution curves tend away from that particular solution of P(t) with initial condition P(0)=P1*=0.

c)

```
r1=1.1;
A=P(15,1000,1.1,30);
Eq1=A(1,end);

r2=1.5;
B=P(15,1000,1.5,30);
Eq2=B(1,end);

r3=2;
C=P(15,1000,2,30);
Eq3=C(1,end);

r4=2.5;
D=P(15,1000,2.5,30);
Eq4=D(1,end);

r5=2.9;
E=P(15,1000,2.9,30);
Eq5=E(1,end);

r=[1.1,1.5,2,2.5,2.9];
Equilibria=[Eq1,Eq2,Eq3,Eq4,Eq5];

plot(r,Equilibria,'k')
xlabel('r')
ylabel('equilibrium_value')

function pop=P(P0,T,r,K)
    pop=zeros(1,T+1);
    pop(1)=P0;
    for t=2:T+1
        pop(t)=r*pop(t-1)*(1-pop(t-1)/K);
    end
end
```



d)

```
clear all; close all; clc
r1=3.1;
A=P(15,1000,3.1,30)
P1000r1=A(1,end)
P999r1=A(1,end-1)

r2=3.2;
B=P(15,1000,3.2,30);
P1000r2=B(1,end);
P999r2=B(1,end-1);

r3=3.3;
C=P(15,1000,3.3,30);
P1000r3=C(1,end);
P999r3=C(1,end-1);

r4=3.4;
D=P(15,1000,3.4,30);
P1000r4=D(1,end);
P999r4=D(1,end-1);

r5=3.44;
E=P(15,1000,3.44,30);
P1000r5=E(1,end);
P999r5=E(1,end-1);

r=[3.1,3.2,3.3,3.4,3.44];
P1000=[P1000r1,P1000r2,P1000r3,P1000r4,P1000r5];
P999=[P999r1,P999r2,P999r3,P999r4,P999r5];

hold on
plot(r,P1000,'r')
plot(r,P999,'k')
xlabel('r')
ylabel('equilibrium_value')
```