Chapter 9
Solved Problems

Problem 1

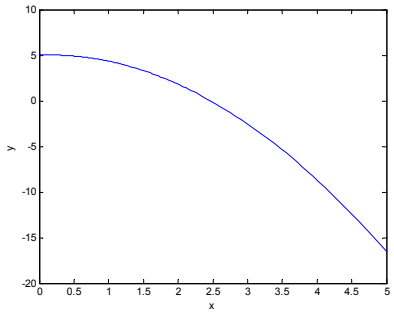
Script file:

```
F=@ (x) exp(0.3*x)-x^2+4;
fplot(F,[0 5])
xlabel('x')
ylabel('y')
r=fzero(F,3)
```

Command Window:

```
r =
    2.4693
```

Figure:



Problem 2

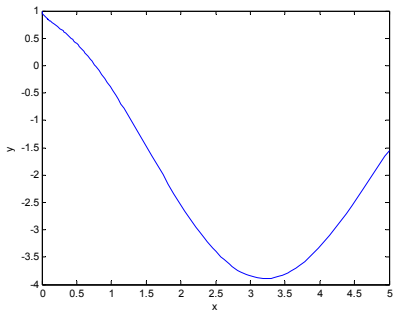
Script file:

```
F=@ (x) 2*cos(x)-0.5*sqrt(x)-1;
fplot(F,[0 5])
xlabel('x')
ylabel('y')
r=fzero(F,3)
```

Command Window:

```
r =
    0.7683
```

Figure:



Problem 3

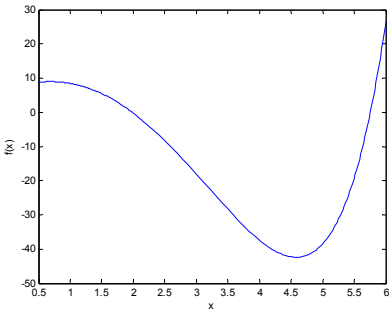
Script file:

```
F=@ (x) x^3-5*x^2.5+exp(0.9*x)+4*(x+1)+2;
fplot(F,[0.5 6])
xlabel('x')
ylabel('f(x)')
x1=fzero(F,2)
x2=fzero(F,5)
```

Command Window:

```
x1 =
    1.9830
x2 =
    5.7555
```

Figure:



Problem 4

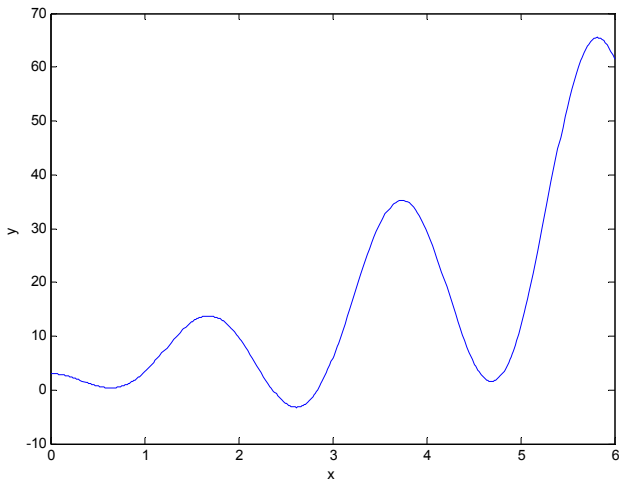
Script file:

```
F=@ (x) x^2-5*x*sin(3*x)+3;
fplot(F,[0 6])
xlabel('x')
ylabel('y')
r1=fzero(F,2)
r2=fzero(F,3)
```

Command Window:

```
r1 =
    2.3656
r2 =
    2.8435
```

Figure:



Problem 5

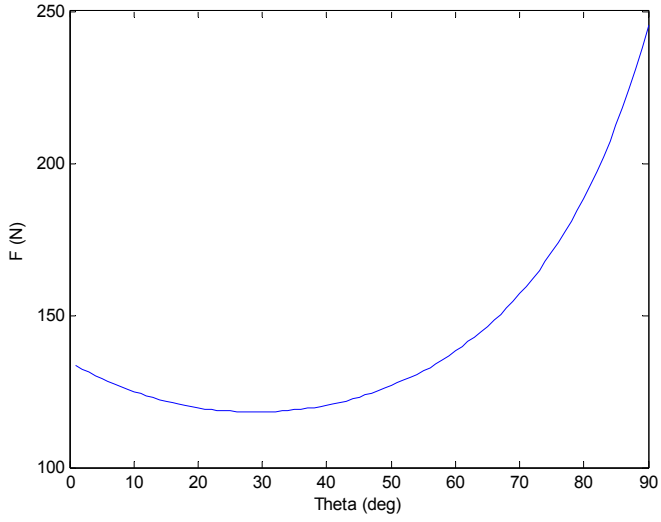
Script file:

```
mu=0.55; g=9.81; m=25;
Fun=@ (x) mu*m*g./(cosd(x)+mu*sind(x));
x=1:90;
F=Fun(x);
plot(x,F)
xlabel('Theta (deg)')
ylabel('F (N)')
Fs=150;
Funs=@ (x) mu*m*g./(cosd(x)+mu*sind(x))-Fs;
ths=fzero(Funs,70)
```

Command Window:

```
ths =
   66.8176
```

Figure:



Problem 6

Script file:

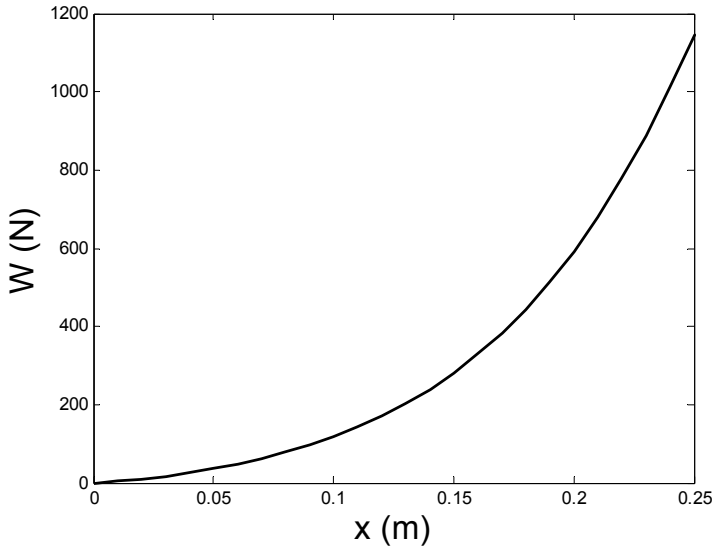
```
a=0.22; b=0.08; K=1600; W=400; K2=100000;
L0=sqrt(a^2+b^2);
L=@ (x) sqrt(a^2+(b+x).^2);
F=@ (x) (L(x)-L0)*K+(L(x)-L0).^3*K2;
xp=0:0.01:0.25;
Fp=2*F(xp).*(b+xp)./L(xp);
plot(xp,Fp,'k','linewidth',2)
xlabel('x (m)','fontsize',18)
ylabel('W (N)','fontsize',18)
f=@(x) 2*F(x).*(b+x)./L(x)-W;
d=fzero(f,0.1)
```

Command Window:

```
d =
    0.1729
```

Answer: $x = 0.1729$m.

Figure:



Problem 7

Script file:

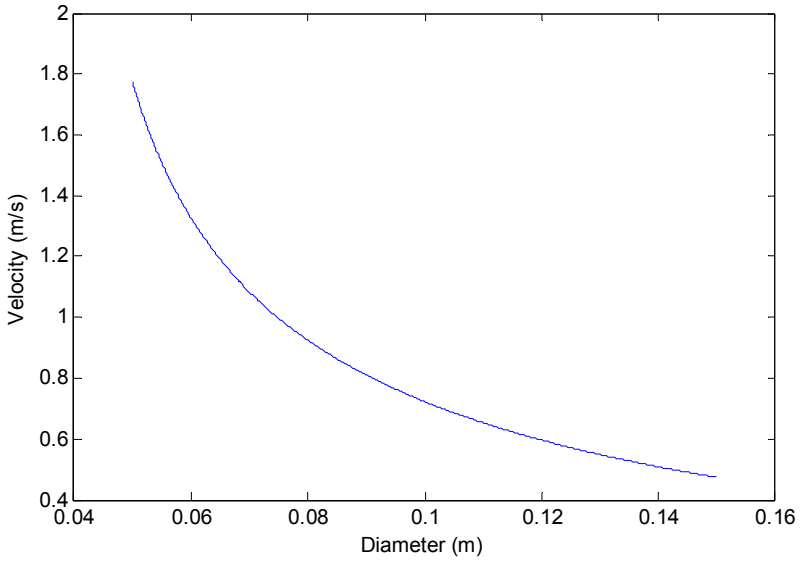
```
M=0.1; g=9.81; C=1;row=1000; beta=10; tet=10;
%d=0.1
F=@(x) sqrt(16*M*g./(pi*C*row*x.^2))./(sqrt(1-
(8*M*tand(beta)^2)./(pi*x.^3*C*row*sind(tet))))-0.8;
dia=fzero(F,0.12)
Fp=@(x) sqrt(16*M*g./(pi*C*row*x.^2))./(sqrt(1-
(8*M*tand(beta)^2)./(pi*x.^3*C*row*sind(tet))));
xp=0.05:0.0001:0.15;
Velp=Fp(xp);
plot(xp,Velp)
xlabel('Diameter (m)')
ylabel('Velocity (m/s)')
```

Command Window:

```
dia =
    0.0911
```

Answer: *diameter* = 0.0911m.

Figure:



Problem 8

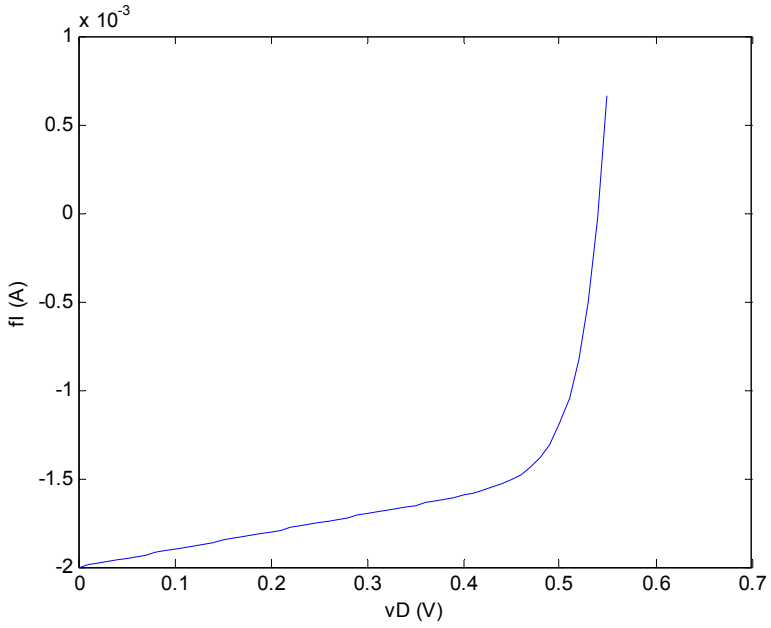
Script File:

```
Is=1E-12; q=1.6E-19; k=1.38E-23;
Vs=2; R=1000;
T=297;
fI=@(vD) Is*(exp((vD*q)./(k*T))-1)-(Vs-vD)./R;
vD=0:0.01:0.55;
Ip=fI(vD);
plot(vD,Ip)
xlabel('vD (V)')
ylabel('fI (A)')
vDSol=fzero(fI, 0.5)
```

Command Window:

```
vDSol =
   0.5405
```

Figure:



Problem 9

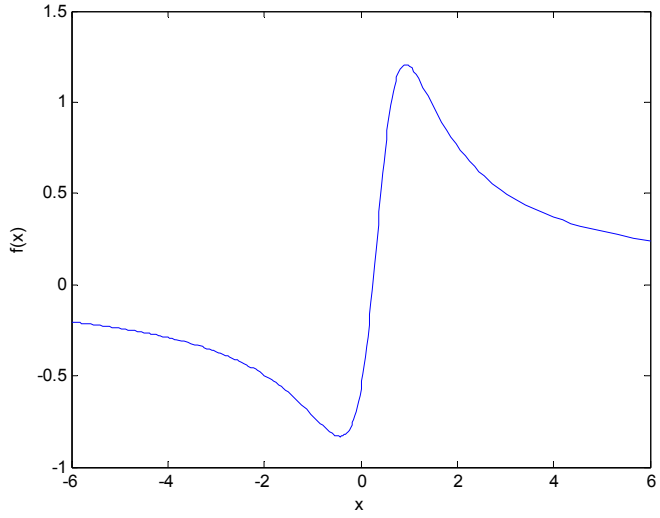
Script file:

```
F = @ (x) 3*(x-0.25)/(1+3.5*(0.8*x-0.3)^2);
Finv = @ (x) -3*(x-0.25)/(1+3.5*(0.8*x-0.3)^2);
fplot(F,[-6 6])
xlabel('x')
ylabel('f(x)')
[xmin, fmin]=fminbnd(F,-2,0)
[xmmax, fmax]=fminbnd(Finv,0,3))
```

Command Window:

```
xmin =
   -0.4298
fmin =
   -0.8321
xmmax =
    0.9297
fmax =
   -1.2071
```

Figure:



Problem 10

Script file:

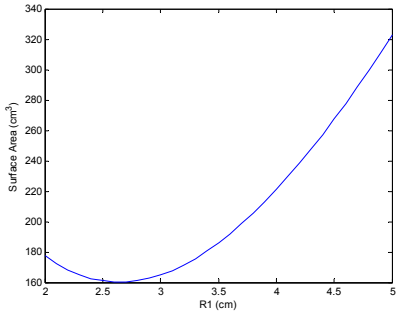
```
V=250;
R1=2:0.1:5;
R2=2*R1;
h=3*V./(pi*(R1.^2+R2.^2+R1.*R2));
S=pi*(R1+R2).*sqrt((R2-R1).^2+h.^2)+pi*R1.^2;
plot(R1,S)
xlabel('R1 (cm)')
ylabel('Surface Area (cm^3)')
SUR=@ (x) pi*(x+2*x)*sqrt((2*x-x)^2+(3*V/
(pi*(x^2+(2*x).^2+x.*2*x))).^2)+pi*x.^2;
R1min=fminbnd(SUR,1,5)
R2min=2*R1min
H=3*V./(pi*(R1min.^2+R2min.^2+R1min.*R2min))
```

Command Window:

```
R1min =
    2.6448
R2min =
    5.2897
H =
    4.8755
```

Answer: $R_1 = 2.6448$ cm, $R_2 = 5.2897$ cm, and $h = 4.8755$ cm.

Figure:



Problem 11

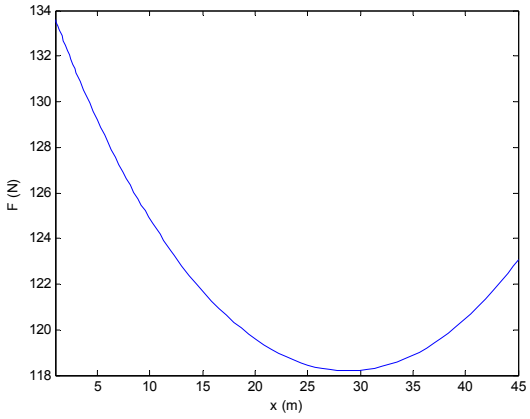
Script file:

```
mu=0.55; g=9.81; m=25;
Fun=@ (x) mu*m*g./(cosd(x)+mu*sind(x));
fplot(Fun,[1,45])
xlabel('x (m)')
ylabel('F (N)')
[xmin Fmin]=fminbnd(Fun, 10, 30)
```

Command Window:

```
xmin =
   28.8108
Fmin =
  118.1906
```

Figure:



Problem 12

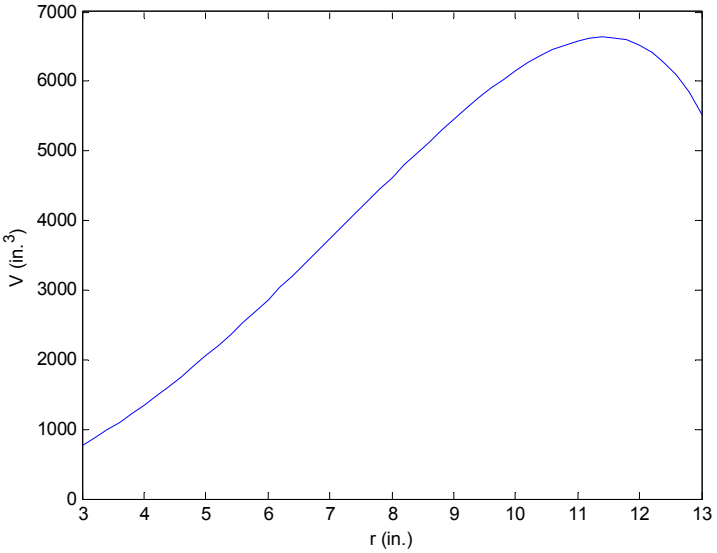
Script file:

```
R=14;
r=3:0.2:13;
h=2*sqrt(R^2-r.^2);
V=pi*r.^2.*h;
plot(r,V)
xlabel('r (in.)')
ylabel('V (in.^3)')
VOL=@ (x) -pi*x^2*2*sqrt(R^2-x^2);
rVmax=fminbnd(VOL,10,13)
hVmax=2*sqrt(R^2-rVmax^2)
```

Command Window:

```
rVmax =
   11.4309
hVmax =
   16.1658
```

Figure:



Problem 13

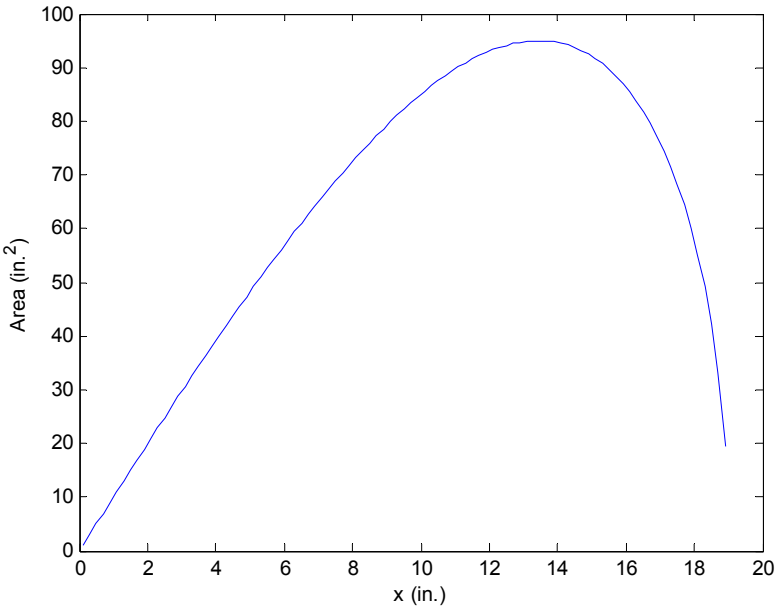
Script file:

```
F=@ (x) x.*sqrt(5^2*(1-x.^2/19^2));
Fneg=@ (x) -x.*sqrt(5^2*(1-x.^2/19^2));
x=0.1:0.2:18.9;
Ap=2*F(x);
plot(x,Ap)
xlabel('x (in.)')
ylabel('Area (in.^2)')
[xAmax]=fminbnd(Fneg,12,16);
aAmax=2*xAmax
bAmax=2*sqrt(5^2*(1-xAmax.^2/19^2))
```

Command Window:

```
aAmax =
   26.8701
bAmax =
    7.0711
```

Figure:



Problem 14

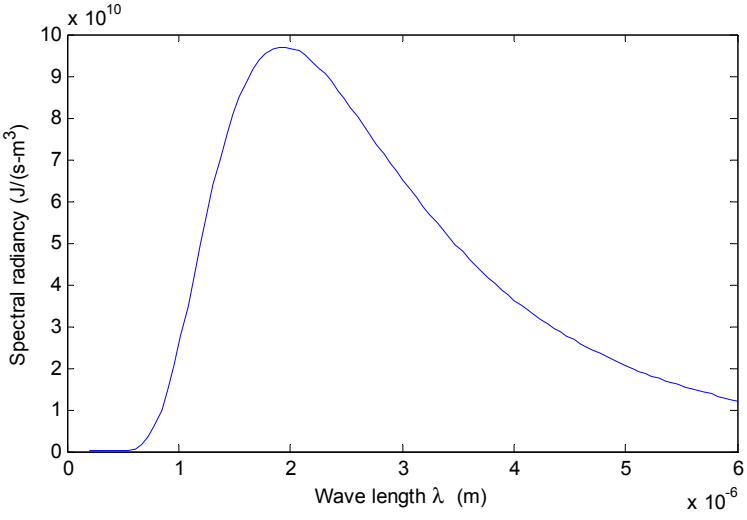
Script file:

```
c=3.0e8; h=6.63e-34; k=1.38e-23; T=1500;
KA=2*pi*c^2*h;  KB=h*c/(k*T);
lmda=linspace(0.2e-6,6e-6,100);
R=(2*pi*c^2*h)./(lmda.^5.*(exp(h*c./(lmda*k*T))-1));
plot(lmda,R)
xlabel('Wave length \lambda  (m)')
ylabel('Spectral radiancy (J/(s-m^3)')
[lmdamax rmax]=fminbnd('(-2*pi*(3.0e8)^2*6.63e-34)/
(x^5*(exp((6.63e-34*3.0e8)/(x*1.38e-23*1500))-1))',1.9e-
6,2e-6)
```

Command Window:

```
lmdamax =
  1.9382e-006
rmax =
 -9.7046e+010
```

Figure:



Answer: Max *R* at λ = 1.9382e-006 m

Problem 15

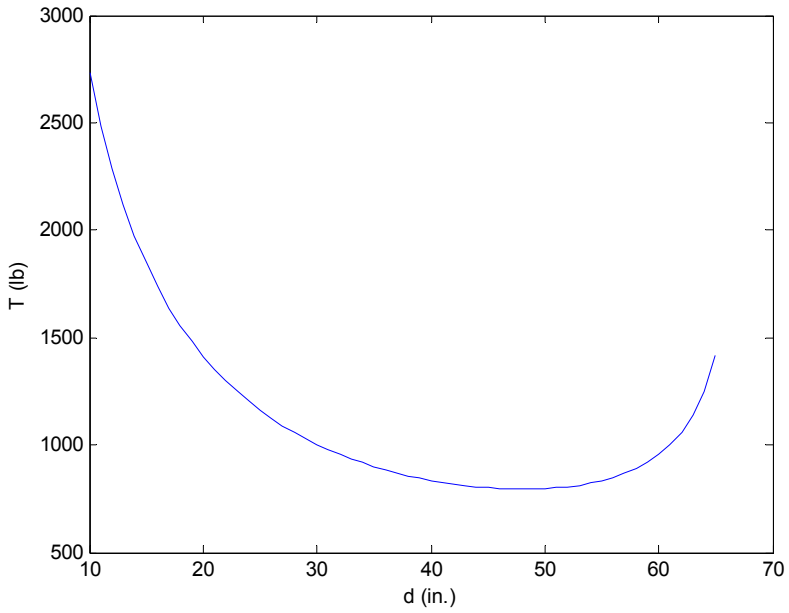
Script file:

```
L=108; Lc=68; W=250;
F= @ (d) W*L*Lc./(sqrt(Lc^2-d.^2).*d);
d=10:65;
T=F(d);
plot(d,T)
xlabel('d (in.)')
ylabel('T (lb)')
[dTmin]=fminbnd(F,40,60)
```

Command Window:

```
dTmin =
  48.0833
```

Figure:



Problem 16

Script file:

```
clear, clc
disp('part (a)')
Fa= @ (x) 0.5*x.^3./(1+2*sqrt(x));
qa=quadl(Fa,2,10)
disp('part (b)')
Fb= @ (x) 0.5+cos(1.2*x)./(x+2).^2;
qa=quadl(Fb,0,9)
```

Command Window:

```
part (a)
qa =
  190.2484
part (b)
qa =
    4.5757
```

Problem 17

Script file:

```
clear, clc
disp('part (a)')
Fa= @ (x) exp(x)./x.^3;
qa=quadl(Fa,1,8)
disp('part (b)')
Fb= @ (x) cos(x).*exp(sqrt(x));
qa=quadl(Fb,0,4*pi)
```

Command Window:

```
part (a)
qa =
   12.3621
part (b)
qa =
    3.5934
```

Problem 18

Script file:

```
t=[0:7];
v=[0 14 39 69 95 114 129 139];
vfps=v*5280/3600;
xft=trapz(t,vfps)
```

Command Window:

```
xft =
  776.6000
```

Problem 19

$$\frac{df(x)}{dx} = -\frac{68.8}{99.7}\sinh\left(\frac{x}{99.7}\right)$$

Script file:

```
a=299.25;
F=@ (x) sqrt(1+(-68.8/99.7*sinh(x/99.7)).^2);
Larch=quadl(F,-a,a)
```

Command Window:

```
Larch =
   1.4800e+03
```

Problem 20

Script file:

```
vmax=80; R=0.25; n=7;
F=@ (x) 2*pi*vmax*(1-x/R).^(1/n).*x;
Q=quad(F,0,R)
```

Command Window:

```
Q =
   12.8282
```

Problem 21

Script file:

```
seg=300e-6; eps=8.85e-12; z=0.05;
K=seg*z/(4*eps);
E=K*quad('(0.05^2+r.^2).^(-3/2)*2.*r',0,0.06)
```

Command Window:

```
E =
  6.0986e+006
```

Answer: E = 6.0986e+006 N/C.

Problem 22

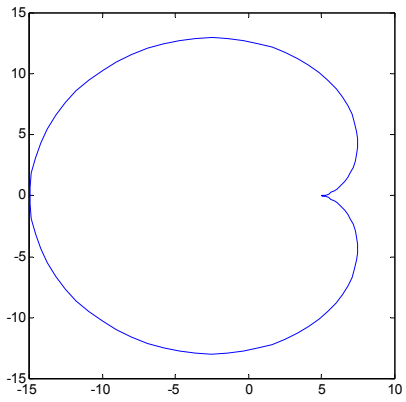
Script file:

```
clear, clc
t=linspace(0,2*pi,100);
b=5;
x=2*b*cos(t)-b*cos(2*t);
y=2*b*sin(t)-b*sin(2*t);
plot (x,y)
axis square
xd=-2*b*sin(t)+2*b*sin(2*t);
yd=2*b*cos(t)-2*b*sin(2*t);
F= @ (x) sqrt((-2*b*sin(x)+2*b*sin(2*x)).^2+(2*b*cos(x)-
2*b*sin(2*x)).^2);
L=quadl(F,0,2*pi)
```

Command Window:

```
L =
   80.6566
```

Figure:



Problem 23

Command Window:

```
>> U=quad('500*6371000^2*9.81./(6371000+x).^2',0,800000)
U =
  3.4862e+009
```

Problem 24

Script file:

```
x=0:40:440;
d=[0 40 96 140 147 121 117 139 140 62 18 0];
A=trapz(x,d)
```

Command Window:

```
A =
       40800
```

Problem 25

The coordinates of the border y at 50-mile increments of x are as follows:

x	0	50	100	150	200	250	300	350	400	450	500
above	0	0	0	0	0	300	300	300	175	150	125
below	0	50	100	175	200	150	150	200	300	375	400

x	550	600	650	700	750
above	125	125	125	125	0
below	400	250	225	150	150

Script file:

```
clear, clc
x=0:50:750;
y_above=[0 0 0 0 0 300 300 300 175 150 125 125 125 125 125
0];
y_below=[0 50 100 175 200 150 150 200 300 375 400 400 250 225
150 150];
A=trapz(x,y_above)+trapz(x,y_below)
```

Command Window:

```
A =
      252500
```

Answer: Area is 252,500 square miles. (Actual area 261,797 square miles)

Problem 26

Script file:

```
a=40; b=15;
F=@ (x) x.*sqrt(1-(x.^2/a^2));
A=pi*a*b/2;
My=2*b*quad(F,0,a);
xcent=My/A
```

Command Window:

```
xcent =
   16.9765
```

Problem 27

Script file:

```
a=5.9065e9; b=5.7208e9;
k=sqrt(a^2-b^2)/a;
F=@ (x) sqrt(1-k^2*sin(x).^2);
q=quad(F,0, pi/2);
P=4*a*q;
% Number of hours in 248 years.
hrs=24*365*248
vAve=P/hrs
```

Command Window:

```
vAve =
  1.6815e+004
```

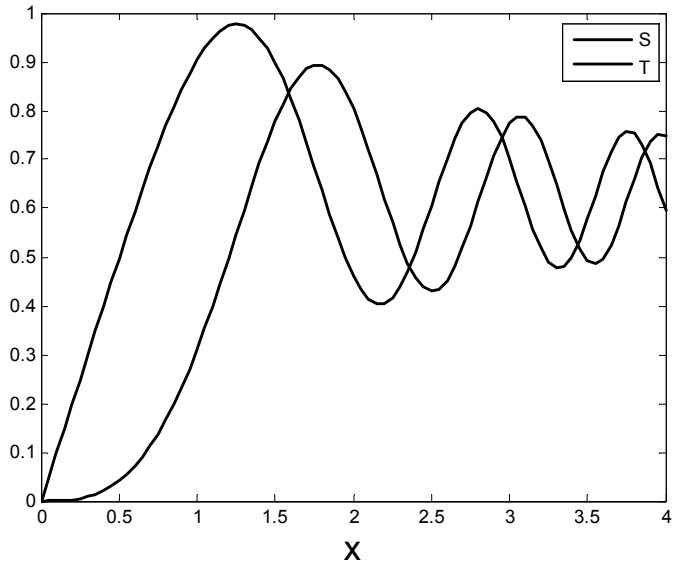
Answer: Average speed 1.6815e+004 km/h

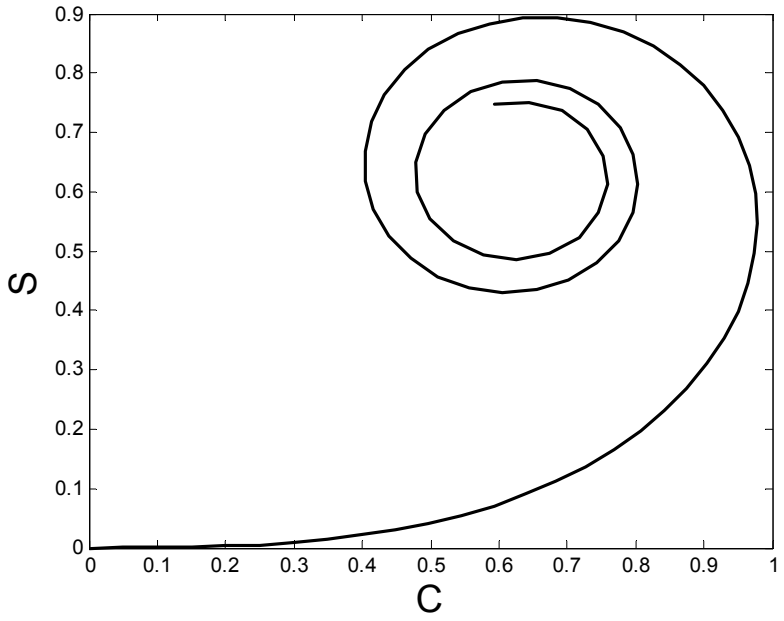
Problem 28

Script file:

```
si=@(x) sin(x.^2);
co=@ (x) cos(x.^2);
x=0:0.05:4;
n=length(x);
for i=1:n
    S(i)=quad(si,0,x(i));
    C(i)=quad(co,0,x(i));
end
plot(x,S,'k-',x,C,'k--','linewidth',2)
%legend('S','T','fontsize',18)
legend('S','T')
xlabel('x','fontsize',18)
figure
plot(C,S,'k','linewidth',2)
xlabel('C','fontsize',18)
ylabel('S','fontsize',18)
```

Figures:



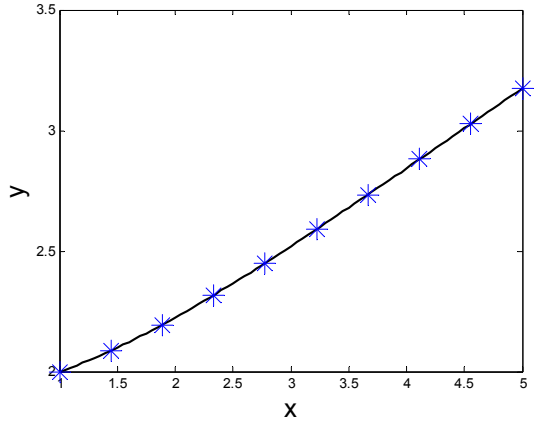

0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
S
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
C

Problem 29

Script file:

```
a=1; b=5;
ya=2;
F=@(x,y) 2*x/(3*y^2);
[x y]=ode45(F,[a:0.05:b],ya);
plot(x,y,'k','linewidth',2)
xlabel('x','fontsize',18)
ylabel('y','fontsize',18)
xp=linspace(a,b,10);
Fsol=@ (x) (x.^2+7).^(1/3);
yp=Fsol(xp);
hold on
plot(xp,yp,'*','markersize',15)
hold off
```

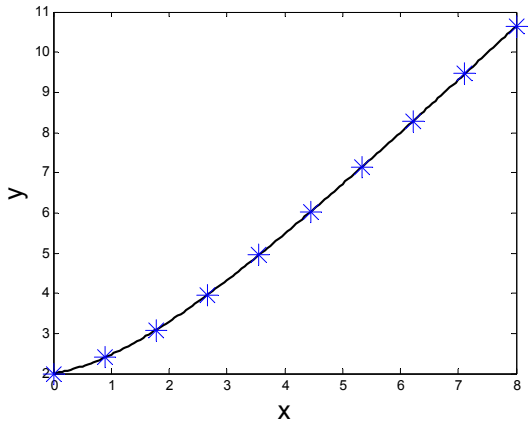
Figure:



Problem 30

Script file:

```
F=@(x,y) (2*x+1)/(y+2);
[x y]=ode45(F,[0:0.05:8],2);
plot(x,y,'k','linewidth',2)
xlabel('x','fontsize',18)
ylabel('y','fontsize',18)
xp=linspace(0,8,10);
Fsol=@ (x) sqrt(2*x.^2+2*x+16)-2;
yp=Fsol(xp);
hold on
plot(xp,yp,'*','markersize',15)
hold off
```

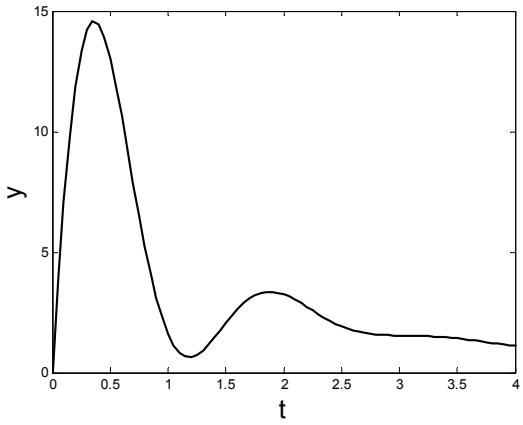


Problem 31

Script file:

```
a=0; b=4;
ya=0;
F=@(t,y) 80*exp(-1.6*t)*cos(4*t)-0.4*y;
[x y]=ode45(F,[a:0.05:b],ya);
plot(x,y,'k','linewidth',2)
xlabel('t','fontsize',18)
ylabel('y','fontsize',18)
```

Figure:

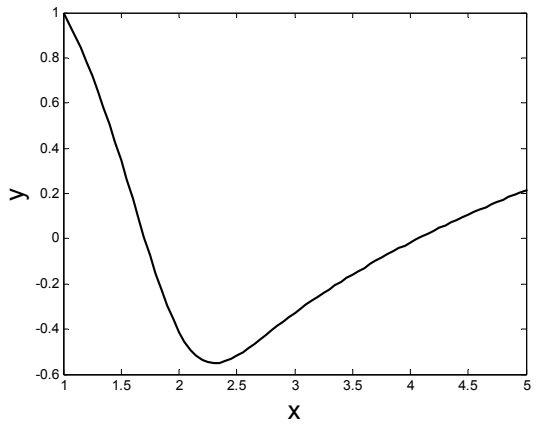


Problem 32

Script file:

```
F=@(x,y) -x^2+x^3*exp(-y)/4;
[x y]=ode45(F,[1:0.05:5],1);
plot(x,y,'k','linewidth',2)
xlabel('x','fontsize',18)
ylabel('y','fontsize',18)
```

Figure:

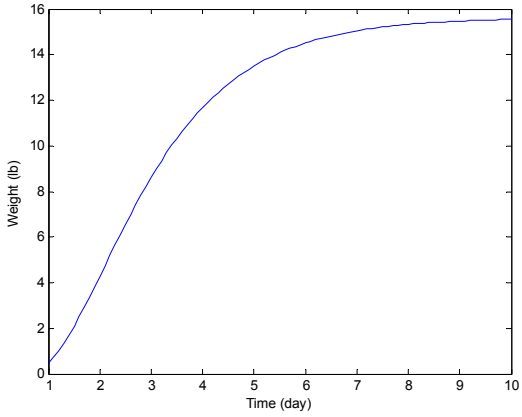


Problem 33

Script file:

```
clear, clc
a=5; b=2;
dwdt=@ (t,w) a*w^(2/3)-b*w;
wa=0.5;
[t w]=ode45(dwdt,[1:0.1:10],wa);
plot(t,w)
xlabel('Time (day)')
ylabel('Weight (lb)')
```

Figure:



Problem 34

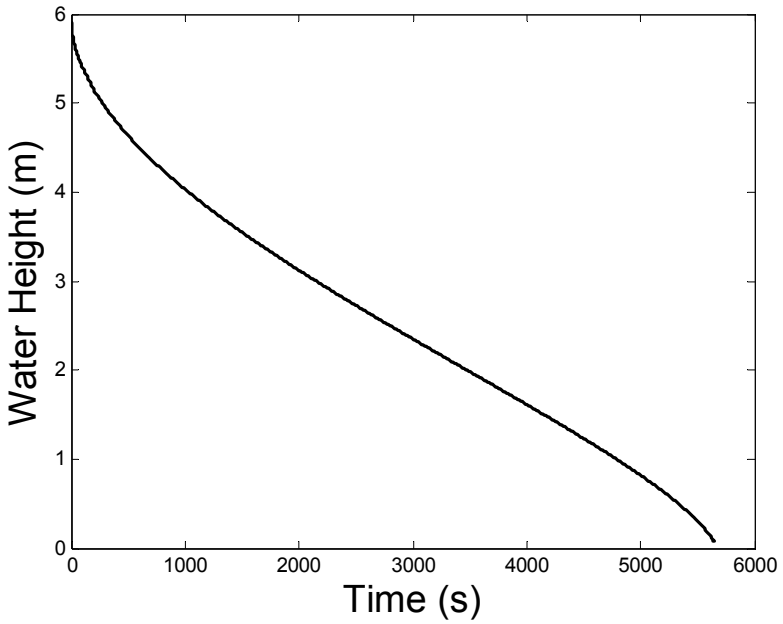
Script file:

```
a=1.5; b=4; c=3; g=9.81; r=0.025;
rsq=r^2;
dhdt=@ (t,h) sqrt(2*g*h)*rsq/(a*b*(-1+(h-c)^2/c^2));
[t y]=ode45(dhdt,[0:0.1:5642.5],5.9);
plot(t,y,'k','linewidth',2)
xlabel('Time (s)','fontsize',18)
ylabel('Water Height (m)','fontsize',18)
tlast=t(length(t))
ylast=y(length(t))
```

Command Window:

```
tlast =
  5.6425e+003
ylast =
    0.0714
```

Figure:



Problem 35

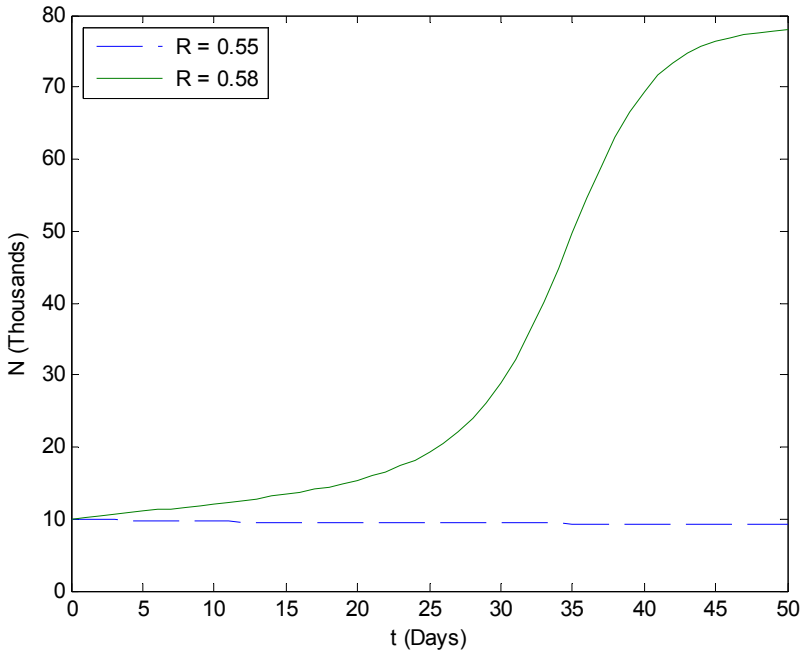
User-defined function:

```
function dNdt=ODEHW9_35_5ed(t,N)
global R
C=100; Nc=10; r=10;
dNdt=R*N*(1-N/C)-r*N^2/(Nc^2+N^2);
```

Script File:

```
global R
R=0.55;
[t1 N1]=ode45(@ODEHW9_35_5ed,[0:1:50],10);
R=0.58;
[t2 N2]=ode45(@ODEHW9_35_5ed,[0:1:50],10);
plot(t1,N1,'--',t2,N2,'-')
xlabel('t (Days)')
ylabel('N (Thousands)')
legend(' R = 0.55',' R = 0.58',2)
```

Figure:

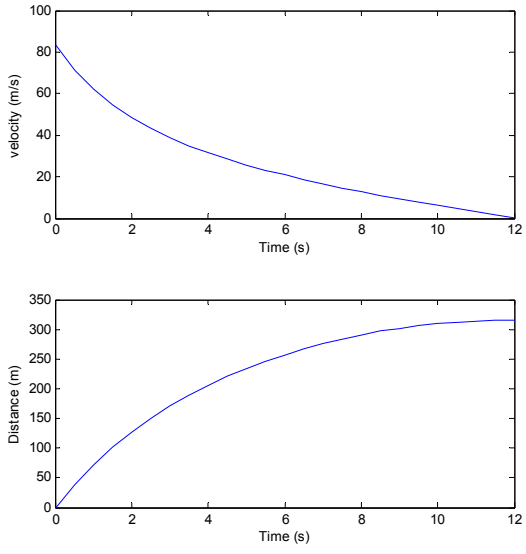


Problem 36

Script file:

```
dvdt= @ (t,v)-0.0035*v^2-3;
[t v]=ode45(dvdt,[0:0.5:12],83.33);
subplot(2,1,1)
plot(t,v)
xlabel('Time (s)')
ylabel('velocity (m/s)')
n=length(t);
x(1)=0;
for i=2:n
    ti=t(1:i);
    vi=v(1:i);
x(i)=trapz(ti,vi);
end
subplot(2,1,2)
plot(t,x)
xlabel('Time (s)')
ylabel('Distance (m)')
```

Figure:

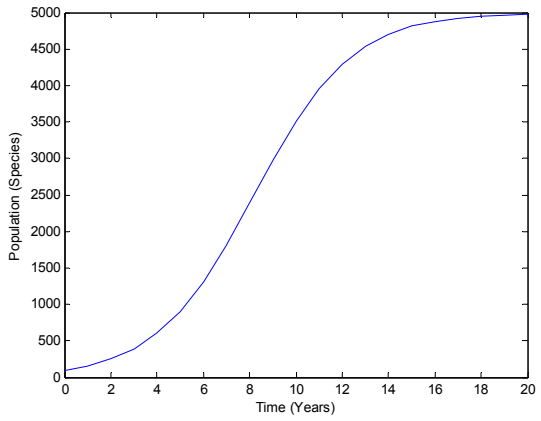


Problem 37

Script file:

```
mu=0.000095; Nm=5000;
dNdt=@ (t,N) mu*N*(Nm-N);
[t N]=ode45(dNdt,[0:20],100);
plot(t,N)
xlabel('Time (Years)')
ylabel('Population (Species)')
```

Figure:

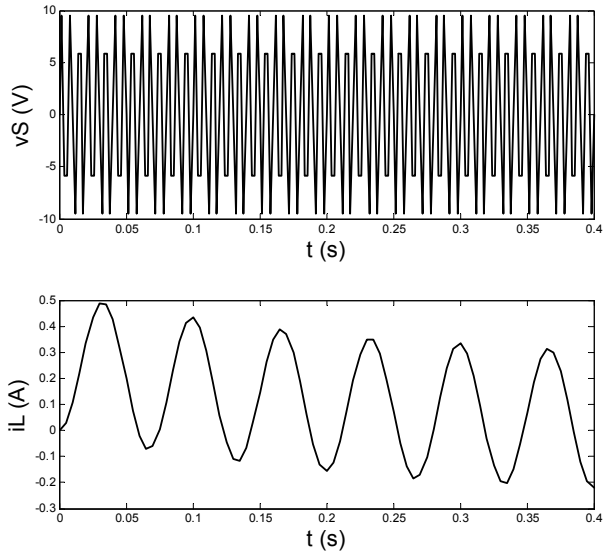


Problem 38

(*a*)
Script file:

```
R=1.80; L=0.4;
FvS=@ (t) 10*sin(3*pi*t/0.01);
dydt=@ (t,y) (10*sin(3*pi*t/0.1)-y*R)/L;
[t iL]=ode45(dydt,[0:0.005:0.4],0);
tp=0:0.002:0.4;
vs=FvS(tp);
subplot(2,1,1)
plot(tp,vs,'k','linewidth',2)
xlabel('t (s)','fontsize',18)
ylabel('vS (V)','fontsize',18)
subplot(2,1,2)
plot(t,iL,'k','linewidth',2)
xlabel('t (s)','fontsize',18)
ylabel('iL (A)','fontsize',18)
```

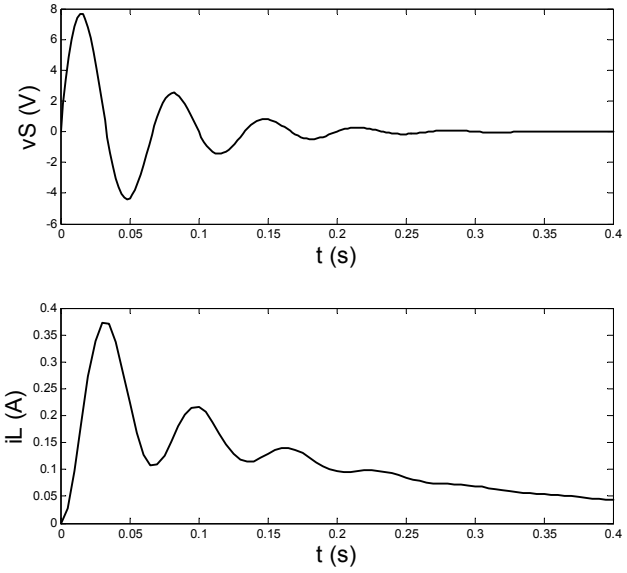
Figure:



(*b*)
Script file:

```
R=1.80; L=0.4;
FvS=@ (t) 10*exp(-t/0.06).*sin(3*pi*t/0.1);
dydt=@ (t,y) (10*exp(-t/0.06)*sin(3*pi*t/0.1)-y*R)/L;
[t iL]=ode45(dydt,[0:0.005:0.4],0);
tp=0:0.002:0.4;
vs=FvS(tp);
subplot(2,1,1)
plot(tp,vs,'k','linewidth',2)
xlabel('t (s)','fontsize',18)
ylabel('vS (V)','fontsize',18)
subplot(2,1,2)
plot(t,iL,'k','linewidth',2)
xlabel('t (s)','fontsize',18)
ylabel('iL (A)','fontsize',18)
```

Figure:

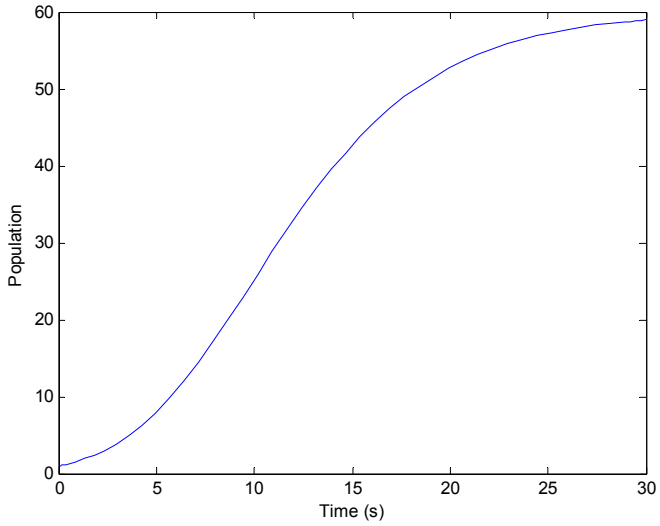


Problem 39

Script file:

```
a=0.8; k=60;
dNdt=@ (t,N) a*N*(1-(N/k)^0.25);
[t N]=ode45(dNdt,[0 30],1);
plot(t,N)
xlabel('Time (s)')
ylabel('Population')
```

Figure:



Problem 40

Script file:

```
m=5; g=9.81;
dvdt=@ (t,v) -g+0.05*v^2/m;
[t v]=ode45(dvdt,[0:0.1:15],0);
plot(t,v)
xlabel('Time (s)')
ylabel('Velocity (m/s)')
```

Figure: