Appendix B: **Sample Code**

%% SIMPLE FREE FALL

% Neglecting drag or anything like that

% Neglecting drag, Felix would have hit the ground in 87 seconds

y = h0 -0.5\*g\*t.^2;

figure(1);

plot(t,y)

title('Free Fall');

xlabel('Time from jump [s]');

ylabel('Vertical position [m]');

ylim([0 h0]);

%hits ground at about 87s

%Euler's Method

%(d^2y/dt^2)= f(y,dy/dt,t)

% v= dy/dt

%(d^2y/dt^2)= dv/dt

% Create two 2st order ODE's

% (1) dv/dt= f(y,v,t)

% (2) dy/dt=v

%MODEL

%m\*(dv/dt)= mg(y)- b(y)v-c(y)v^2

%PARAMETERS

g=9.8; %gravity in m/s^2

m=110; %mass in kg

D=1.3; %diameter in m

%density of air (at STP, sea level, in kg/m^3)

rho= 1.225;

%density model

H=8500;

%density of different parts of atmosphere

%for upper stratosphere h>25000

hUS=25000:1:38970;

%temperature

TUS = -131.21 + .00299 \* hUS;

%pressure

pUS=2.488\*(((TUS+273.1)/216.6).^-11.388);

%density

rUS = pUS ./ (.2869 \* (TUS + 273.1));

%plot(rUS,hUS)

%for lower stratosphere 11,000<h<25000

hLS=11000:1:24999;

TLS=-56.46;

pLS=22.65\*exp(1.73-0.000157.\*hLS);

rLS=pLS./(0.2869\*(TLS+273.1));

%plot(rLS,hLS)

%for troposphere h<11000

hT=0:1:10999;

TT=15.04-0.00649\*hT;

pT=101.29\*((((TT+273.1)/288.08)).^5.256);

rT=pT./(0.2869\*(TT+273.1));

%atmosphere density model total

rtot=[rUS rLS rT];

htot=[hUS hLS hT];

clear rUS rLS rT hUS hLS hT TLS TT TUS pLS pT pUS

figure(5);

plot(rtot, htot, '.')

title('Atmospheric Density');

xlabel('Denisty (kg/m^3)');

ylabel('Vertical position [m]');

%create viscosity matrix that ends goes to 0 as quadratic term overtakes

%linear term

visc=[];

for height=1:1:38970;

if (height>35000)

visc(height) = 1.54559\*(10^-5);

elseif (height>30000 && height<35000)

visc(height)= 1.4883\*(10^-5);

elseif (height>25000 && height<30000)

visc(height)=1.46\*(10^-5);

elseif (height>20000 && height<25000)

visc(height)=1.43226\*(10^-5);

elseif (height>15000&& height<20000)

visc(height)= 1.43226\*(10^-5);

elseif (height<15000)

visc(height)=0;

end

end

%INITIAL CONDITIONS

to=0;

% y(to) (m)

yo= 38970;

% v(to)= (m/s)

vo= 0;

y=[];

v=[];

%initialize

yold= yo;

vold= vo;

yindex=yo;

%repeat forever (change increment systematically, start with delta t=1s)

%h= delta t;

h=1;

%c= (pi/16)\*rho\*D^2;

%N= viscosity at STP

N=1.812\*(10^-5);

%Felix reached mach1 34 seconds into freefall

for t=0:h:500

%(1) vnew= vold + F(yold, vold, t)\*h

c= (pi/16)\*rho\*exp(-yold/H)\*(D^2);

b= 3\*pi\*visc(yindex)\*D;

vterquad= sqrt(m\*g/c);

vterlin= m\*g/b;

% b is extremely small, even at early times

%with linear term

%vnew= vold + (g + b\*vold +(c\*(D^2)/m)\*(vold^2))\*h;

%without linear term

vnew= vold + (g +(c\*(D^2)/m)\*(vold^2))\*h;

ynew= yold - vold\*h;

if ynew<0

break

end

if vnew>vterquad

%stop vnew when it reaches terminal velocity

vnew=vterquad;

v(t+1)=vnew;

else

v(t+1)=vnew;

end

%fill y matrix with ynew

y(t+1)= ynew;

yold= ynew;

vold= vnew;

yindex= int32(yold);

%t = t+h, done by for loop

end

figure(1);

plot(y);

title('y(t), Quadratic Term');

xl=xlabel('time (s)');

ylabel('position (m)');

figure(2);

plot(v);

title('v(t), Quadratic Term');

xlabel('time (s)');

ylabel('speed (m/s)')