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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% CODE CHALLENGE 9 - Guided Template Script
%
% The purpose of this challenge is to propagate an orbit in a two body
% system for one period, and to plot it's specific energy over time.
%
% To complete the challenge, execute the following steps:
% 1) Set an initial condition vector
% 2) Propagate for exactly period of the orbit
% 3) Calculate the specific energy of the s/c vs. time
% 4) Plot the trajectory, include points for where the trajectory
 starts,
% ends, and the where the Earth is.
% 5) Plot the change in specific energy vs. time
%
% NOTE: DO NOT change any variable names already present in the code.
%
% Upload your team's script to Gradescope when complete.
%
% NAME YOUR FILE AS Challenge9_Sec{section number}_Group{group
 breakout #}.m
% ***Section numbers are 1 or 2***
% EX File Name: Challenge9_Sec1_Group15.m
% Challenge9_Sec2_Group6
%
% STUDENT TEAMMATES
% 1) Jack Iribarren
% 2) Ben Helfant
% 3) Qihan Cai
% 4) Andrew Logue
% 5)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

Housekeeping

```
clear variables; close all; clc;
```

Set up

```
mass = 20; %kg
mu = (6.6743*10^(-20))*(5.972*10^(24)); % GM of Earth [km^3/s^2]
r = [10000,0,1000]'; % initial r vetor [km]
v = [0,7.5574,0]'; % initial v vetor [km/s]
a = -1*mu * (((norm(v)).^2)-2*(mu/norm(r))).^(-1); % calculating a
 [km/s^2]
T = 2*(pi)*sqrt((a.^3)/(mu)); % calculating T [s]
IC = [r; v]'; % initial condition vector
t = [0,T]; % time domain [s]
```

Propagate w/ ode45

```
[t,y] = ode45(@(t,y) fun(t,y,mu) , t , IC);
```

Calculate specific energy

```
%energy = (norm(y(:,4:6)).^2)-(2*(mu/norm(y(:,1:3)))); %[J/kg]
L = length(y);
energy = zeros(L,1);
for i=1:L
    r_mag = norm(y(i,1:3));
    v_mag = norm(y(i,4:6));
    energy(i) = (v_mag)^2 - ((2*mu)/r_mag);
end
```

Plotting

```
figure(1)
plot3(y(1,1),y(1,2),y(1,3),'g*'); % plot starting point
hold on; grid minor;
plot3(0,0,0,'bo'); % plot earth
xlabel('x-axis');
ylabel('y-axis');
zlabel('z-axis');
title('Two body orbit for one orbital period');
plot3(y(:,1),y(:,2),y(:,3),'k','LineWidth',1); % plot trajectory
plot3(y(end,1),y(end,2),y(end,3),'r*'); % plot ending point

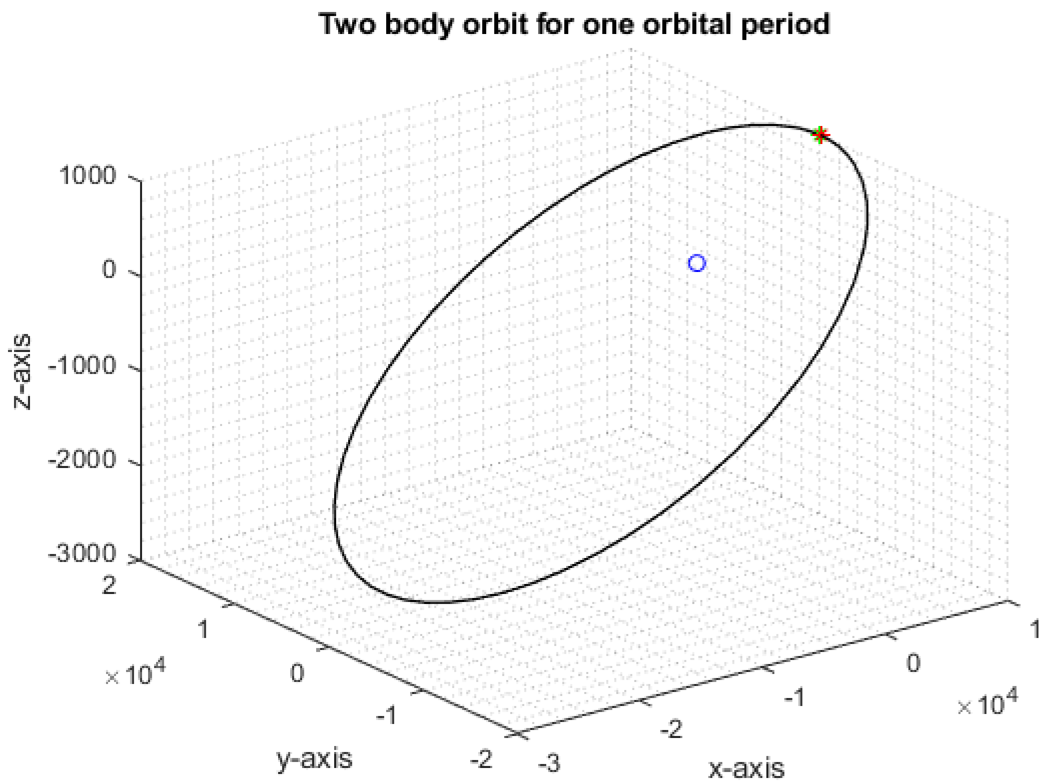
figure(2)
plot(t,energy); %plot specific energy vs. time
grid minor;
xlabel('Time (Seconds)');
ylabel('Energy (Joules/Kg)');
title('Energy vs time for orbit');

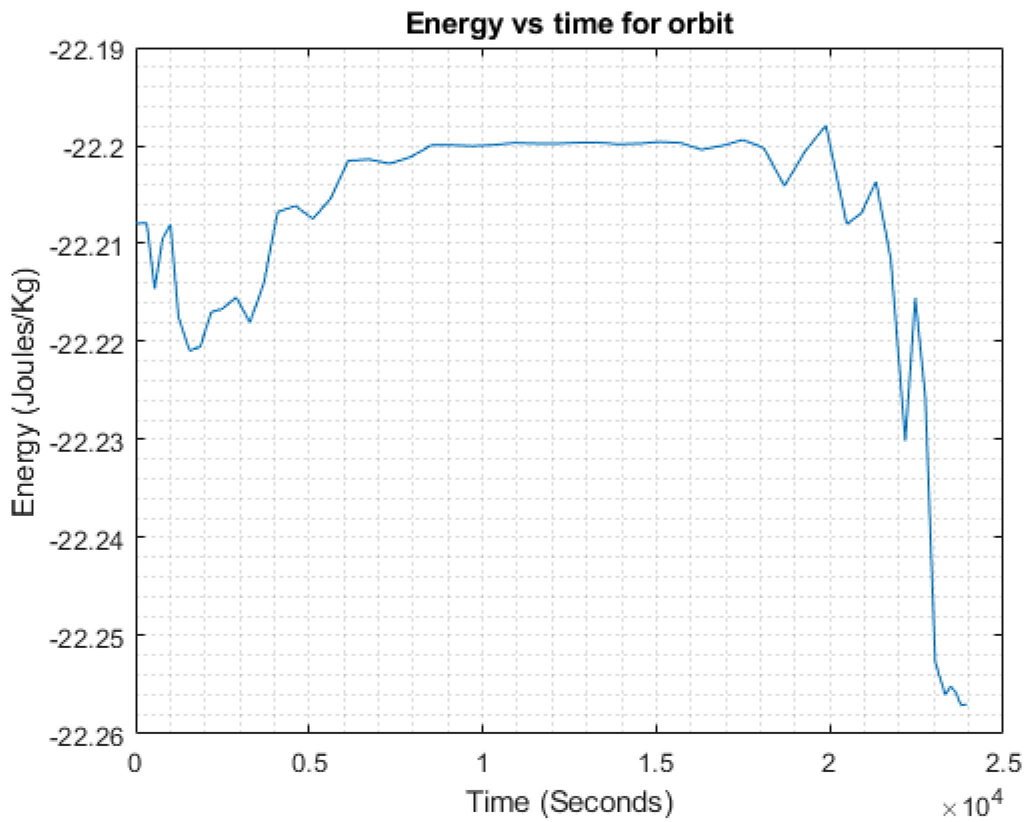
function X_dot = fun(t,y,mu)
    %r''=(-GM/r^3)(r)
```

```
    r_x = y(1);
    r_y = y(2);
    r_z = y(3);
    v_x = y(4);
    v_y = y(5);
    v_z = y(6);

    r_mag = norm(y(1:3));
    r_xdot = ((-1*mu)/(r_mag^3))*r_x;
    r_ydot = ((-1*mu)/(r_mag^3))*r_y;
    r_zdot = ((-1*mu)/(r_mag^3))*r_z;

    X_dot = [v_x, v_y, v_z, r_xdot ,r_ydot , r_zdot]';
end
```





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