QUESTION 4:

```
clear
clc
mu = 398600.4415;
a = 7000;
e = 0;
i = 75;
i = 75*pi/180;
Omega = 0;
u = 0;
elements = [a e i Omega 0 0];
rv = OrbitalElementToCartesian(elements, mu);
rtijk = [rv(1) rv(2) rv(3)]';
vtijk = [rv(4) rv(5) rv(6)]';
rRSW = [25 0 0]';
rRSW = rRSW / 1000;
vRSW = [-1 0 0]';
vRSW = vRSW / 1000;
runit = rRSW / norm(rRSW);
wunit = cross(rRSW,vRSW);
sunit = cross(wunit, runit);
Q = [runit(1) sunit(1) wunit(1); runit(2) sunit(2) wunit(2); runit(3) sunit(3) wunit(3)];
pijk = Q * rRSW;
pderijk = Q * vRSW;
rcoijk = pijk + rtijk;
vcoijk = pderijk + vtijk;

omega = norm(cross(rtijk,vtijk)) / norm(rtijk)^2;
omega = [0 0 omega]';

vrelrsw = vRSW - cross(omega, rRSW);
vrelrsw = vrelrsw * 1000;
dt = 20;
T = 2*pi*(norm(rtijk)^3 / mu)^(1/2);
time = 0:dt:T*3;
xot = rv;
xoc(1:3,1) = rcoijk;
xoc(4:6,1) = vcoijk;
[Tc,Yc] = propCartODE45(xoc, time, mu);
```

```matlab
[Tt,Yt] = propCartODE45(xot, time, mu);
dim = size(Yt);
length = dim(1);
for k = 1:length
    Y(k, 1:3) = Yc(k,1:3)-Yt(k,1:3);
    rt(1:3,1) = Yt(k,1:3)';
    vt(1:3,1) = Yt(k,4:6)';
    Runit = rt / norm(rt);
    Wunit = cross(rt,vt) / norm(cross(rt,vt));
    Sunit = cross(Wunit, Runit);
    Q2 = [Runit Sunit Wunit];
    Q2 = transpose(Q2);
    diffrsw(1:3, k) = Q2*Y(k, 1:3)';
end
figure(1)
plot(diffrsw(2,:) * 1000, diffrsw(1,:) * 1000)
title('Propagated R and S Position Vectors')
xlabel('S in m')
ylabel('R in m')

n = (mu / a^3)^(1/2);

for kk = 1:length
    tf = time(kk);
    pp = phipp(n,tf);
    ppder = phippder(n,tf);
    pderp = phipderp(n,tf);
    pderpder = phipderpder(n,tf);
    rhovec(:,kk) = pp * rRSW + ppder * vRSW;
    error(1:3, kk) = diffrsw(:, kk) - rhovec(:, kk);
end
errormag = norm(error(1:3, length));
figure(2)
subplot(3,1,1)
plot(time, error(1,:))
title('R Error within RSW')
xlabel('Time in Seconds')
ylabel('R Error in m')
subplot(3,1,2)
plot(time, -error(2,:))
title('S Error within RSW')
xlabel('Time in Seconds')
ylabel('S Error in m')
subplot(3,1,3)
plot(time, error(3,:))
title('W Error within RSW')
```

```matlab
xlabel('Time in Seconds')
ylabel('W Error in m')




function [matrix] = phipp(n,t)
nt = n*t;
matrix = [4-3*cos(nt) 0 0; 6*(sin(nt) - nt) 1 0; 0 0 cos(nt)];
end

function [matrix] = phippder(n,t)
nt = n*t;
matrix = [(1/n)*sin(nt) (2/n)*(1-cos(nt)) 0; (2/n)*(cos(nt) - 1) (1/n)*(4*sin(nt) - 3*nt) 0; 0 0
(1/n)*sin(nt)];
end

function [matrix] = phipderp(n,t)
nt = n*t;
matrix = [3*n*sin(nt) 0 0; 6*n*(cos(nt) - 1) 0 0; 0 0 -n*sin(nt)];
end

function [matrix] = phipderpder(n,t)
nt = n*t;
matrix = [cos(nt) 2*sin(nt) 0; -2*sin(nt) 4*cos(nt)-3 0; 0 0 cos(nt)  ];
end
```