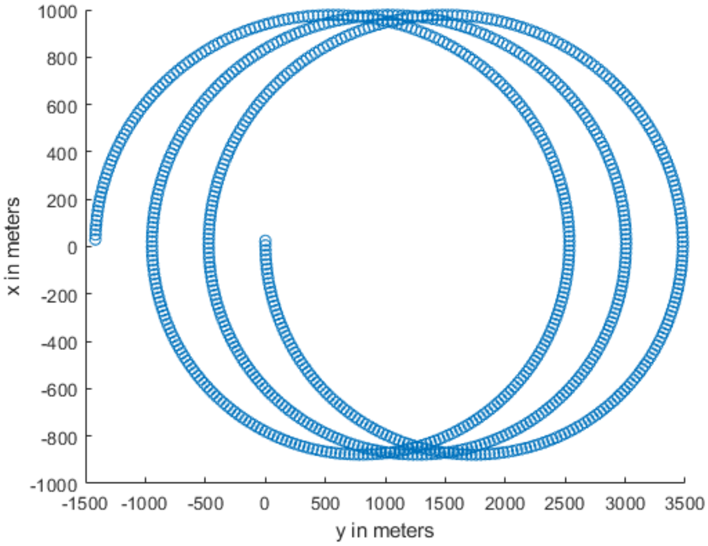
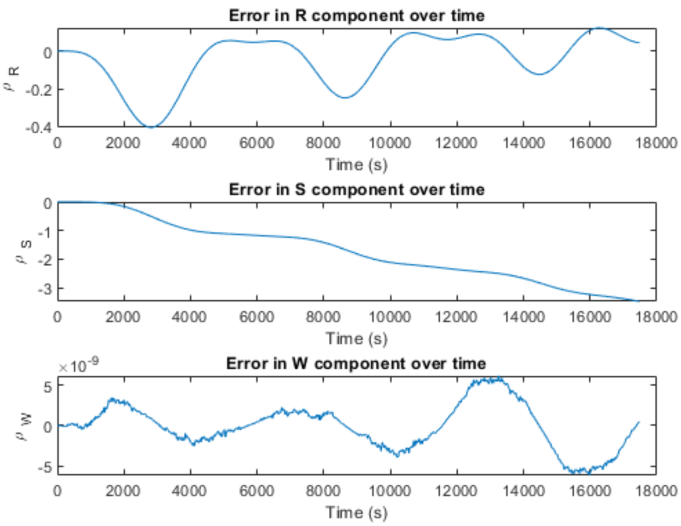
Problem 4

```
clear
clc

mu = 398600.4415;
a = 7000;
e = 0;
i = deg2rad(75);
raan = 0;
argl = 0;

rhoi = [25 0 0]'; % in Inertial RSW
rhodi = [-1 0 0]'; % "

[rt,vt] = oe2rv(mu,a,e,i,raan,0,argl); % in ijk frame

R = rt./norm(rt);
c = cross(rt,vt);
W = c./norm(c);
S = cross(W,R);

Qrswijk = [R S W];

% 4.1
rhoijk = Qrswijk*rhoi; % Changed to ijk and displayed as answers to 4.1 (m)
rhodijk = Qrswijk*rhodi;
disp('4.1 The inertial relative position in ijk is');
disp(rhoijk);
disp('4.1 The inertial relative velocity in ijk is');
disp(rhodijk);



% 4.2
omega = norm(c)/(norm(rt)^2);
omega = [0 0 omega]'; % RSW
rhodni = rhodi - (cross(omega,rhoi)); % Non-inertial relative velocity in RSW (m)
disp('4.2 The non-inertial relative velocity in RSW is');
disp(rhodni);

% 4.3
P = 2*pi*sqrt(a^3/mu);
time = 0:20:3*P;
y0t = [rt; vt]; % initial conditions for target
y0c = y0t + 0.001.*[rhoijk; rhodijk]; % initial conditions for chaser
odeoptions = odeset('RelTol', 1e-10,'AbsTol',1e-20);
[~,Yt] = ode45(@twobody,time,y0t,odeoptions); % propagating target orbit
[t,Yc] = ode45(@twobody,time,y0c,odeoptions); % propagating chaser orbit

for i = 1:length(time)
    Ytr = Yt(:,1:3); % Separating position vectors out
    Ycr = Yc(:,1:3);
    Ytv = Yt(:,4:6);
    Ycv = Yc(:,4:6);

    R = Ytr(i,1:3)./norm(Ytr(i,1:3));
    c = cross(Ytr(i,1:3),Ytv(i,1:3));
    W = c./norm(c);
    S = cross(W,R);

    Qrswijk = [R' S' W'];


    Ytrrsw(i,:) = Qrswijk'*Ytr(i,:)'; % ijk to rsw for each position of target
    Ycrrsw(i,:) = Qrswijk'*Ycr(i,:)'; % ijk to rsw for each position of target
end

x = Ycrrsw(:,1) - Ytrrsw(:,1); % Subtracting R components
y = Ycrrsw(:,2) - Ytrrsw(:,2); % Subtracting S components
x = x*1000; % km to meters
y = y*1000;

figure(1);
scatter(y,x)
xlabel('y in meters')
ylabel('x in meters')

% 4.4
po = rhoi;
pdo = rhodni;
n = 2*pi/P;
```

```
pt = zeros(3,length(time));
dt = zeros(3,length(time));
i = 1;
for t = 0:20:3*P

    phipp = [4-3*cos(n*t) 0 0;
             6*(sin(n*t)-n*t) 1 0;
             0 0 cos(n*t)];
    phipd = [sin(n*t)/n 2*(1-cos(n*t))/n 0;
             2*(cos(n*t)-1)/n (4*sin(n*t)-3*n*t)/n 0;
             0 0 sin(n*t)/n];
    phidp = [3*n*sin(n*t) 0 0;
             6*n*(cos(n*t)-1) 0 0;
             0 0 -n*sin(n*t)];
    phidd = [cos(n*t) 2*sin(n*t) 0;
             -2*sin(n*t) 4*cos(n*t)-3 0;
             0 0 cos(n*t)];

    pt(1:3,i) = phipp*po + phipd*pdo; % solving for relative position using CW
    dt(1:3,i) = phidp*po + phidd*pdo; % ended up being useless, oh well


    i = i+1;
end

pt = pt';

e = (Ycrrsw - Ytrrsw)*1000 - pt;

figure(2);
subplot(3,1,1)
plot(time, e(:,1))
title('Error in R component over time')
xlabel('Time (s)')
ylabel('\rho _{R}')
hold on

subplot(3,1,2)
plot(time, e(:,2))
title('Error in S component over time')
xlabel('Time (s)')
ylabel('\rho _{S}')

subplot(3,1,3)
plot(time, e(:,3))
title('Error in W component over time')
xlabel('Time (s)')
ylabel('\rho _{W}')

% 4.5

ef = norm(e(length(e),:));
message = ['4.5 The final magnitude of error is ', num2str(ef), ' meters.'];
disp(message);

% 4.6

disp('4.6 The CW equations are quite accurate in this case. The error is less than a quarter of a percent of the magnitude of the relative position vector.');
```

```
4.1 The inertial relative position in ijk is
    25
     0
     0

4.1 The inertial relative velocity in ijk is
    -1
     0
     0

4.2 The non-inertial relative velocity in RSW is
   -1.0000
   -0.0270
         0

4.5 The final magnitude of error is 3.4826 meters.
4.6 The CW equations are quite accurate in this case. The error is less than a quarter of a percent of the magnitude of the relative position vector.
```





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