Problem 2

```
addpath(genpath(fileparts(which('pathfile.m'))))
interr = 'latex';
% interr = 'none';
set(groot,'defaulttextinterpreter',interr);
set(groot, 'defaultAxesTickLabelInterpreter',interr);
set(groot, 'defaultLegendInterpreter',interr);
Re = 6378.1;
mu = 398600.4415;
```

Given:

```
r1_I = [3 1 0]'*Re
```

```
r1_I = 3×1
10^4 ×
    1.9134
    0.6378
         0
```

```
r2_I = [-1 2*sqrt(3) 2]'*Re
```

```
r2_I = 3×1
10^4 ×
   -0.6378
    2.2094
    1.2756
```

```
r1 = norm(r1_I)
```

```
r1 = 2.0169e+04
```

```
r2 = norm(r2_I)
```

```
r2 = 2.6298e+04
```

Part a)

```
hhat = cross(r1_I,r2_I)/norm(cross(r1_I,r2_I))
```

```
hhat = 3×1
    0.1535
   -0.4605
    0.8743
```

```
inc = acos(hhat(3)), inc_deg = rad2deg(inc)
```

```
inc = 0.5068
inc_deg = 29.0373
```

Part b)

```
TA = acos(r1_I'*r2_I/r1/r2), TA_deg = rad2deg(TA)
```

```
TA = 1.5352
```

```
TA_deg = 87.9601
```

```
c = sqrt(r1^2 + r2^2 - 2*r1*r2*cos(TA))
```

```
c = 3.2567e+04
```

```
s = 1/2 * (r1+r2+c)
```

```
s = 3.9517e+04
```

```
amin = s/2
```

```
amin = 1.9758e+04
```

```
P1Fm = 2*amin - r1
```

```
P1Fm = 1.9348e+04
```

```
n = sqrt(mu/amin^3)
```

```
n = 2.2732e-04
```

```
alpha0 = 2*asin(sqrt(s/2/amin))
```

```
alpha0 = 3.1416
```

```
beta0 = 2*asin(sqrt((s-c)/2/amin))
```

```
beta0 = 0.8655
```

```
TOFmin = ((alpha0 - sin(alpha0)) - (beta0 - sin(beta0)))/n, TOFmin_hr = TOFmin/3600
```

```
TOFmin = 1.3362e+04
TOFmin_hr = 3.7117
```

Part c)

```
TOF_hr = 3.6, TOF = TOF_hr*3600
```

```
TOF_hr = 3.6000
TOF = 12960
```

```
TOFpar = 1/3 * sqrt(2/mu)*(s^(3/2)-(s-c)^(3/2))
```

```
TOFpar = 5.4328e+03
```

```
[a,alpha,beta] = bisection(TOF,amin,c,mu,'1A',.001)
```

```
a = 1.9769e+04
alpha = 3.0946
beta = 0.8653
```

```
rho = asin(r2/c * sin(TA))
```

```
rho = 0.9390
```

```
p = 4*a*(s-r1)*(s-r2)/c^2 * sin((alpha+beta)/2)^2
```

```
p = 1.6052e+04
```

```
e = sqrt(1-p/a)
```

```
e = 0.4337
```

```
rD = r1
```

```
rD = 2.0169e+04
```

```
rA = r2
```

```
rA = 2.6298e+04
```

```
vD = sqrt(mu*(2/rD - 1/a))
```

```
vD = 4.4003
```

```
vA = sqrt(mu*(2/rA - 1/a))
```

```
vA = 3.1862
```

```
rp = a*(1-e)
```

```
rp = 1.1196e+04
```

```
ra = a*(1+e)
```

```
ra = 2.8343e+04
```

```
tsD = acos(1/e * (p/r1 - 1)), tsD_deg = rad2deg(tsD)
```

```
tsD = 2.0610
tsD_deg = 118.0855
```

```
tsA = tsD+TA, tsA_deg = rad2deg(tsA)
```

```
tsA = 3.5962
tsA_deg = 206.0456
```

```
h = sqrt(mu*p)
```

```
h = 7.9988e+04
```

```
gammaD = acos(h/r1/vD), gammaD_deg = rad2deg(gammaD)
```

```
gammaD = 0.4481
gammaD_deg = 25.6757
```

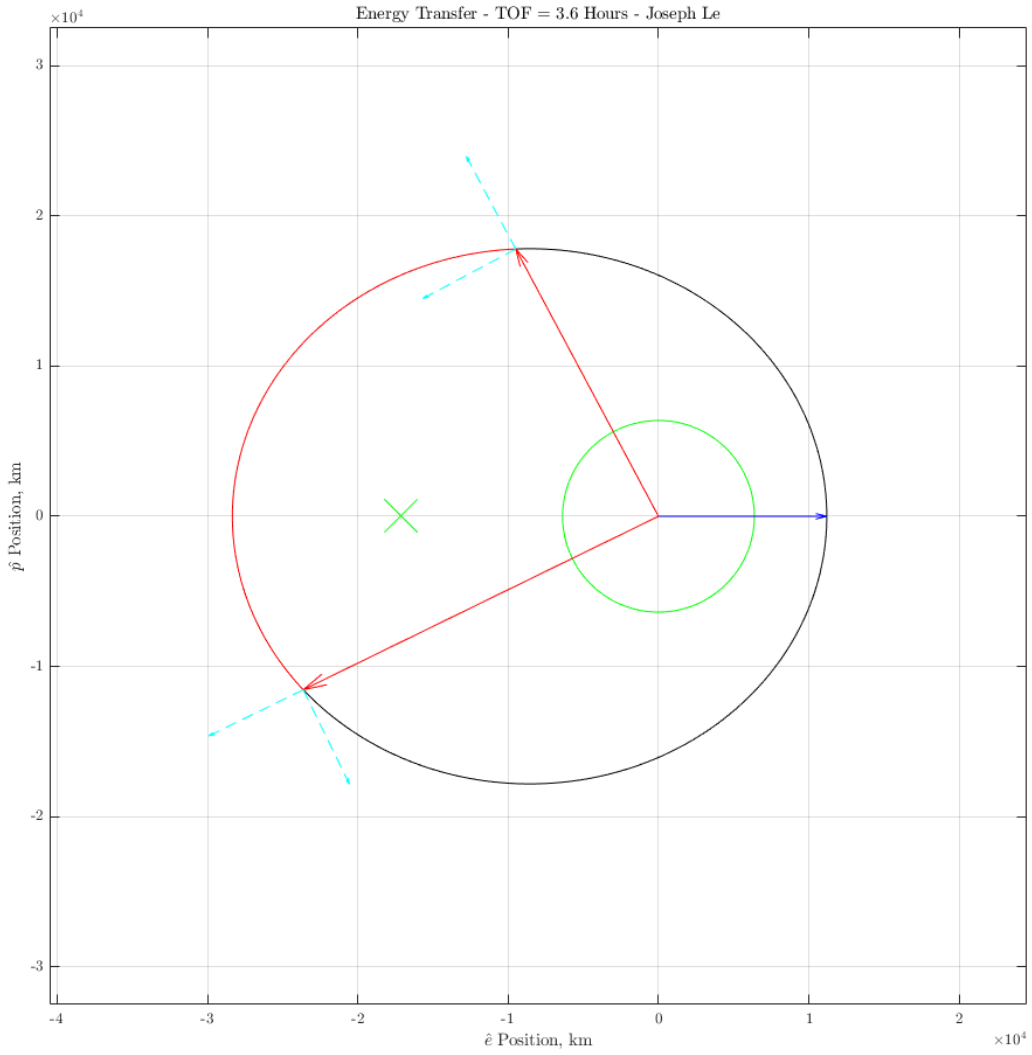
```
gammaA = -acos(h/r2/vA), gammaA_deg = rad2deg(gammaA)
```

```
gammaA = -0.3024
gammaA_deg = -17.3259
```

Part d)

```
plotorbit(a,e,0,2*pi,0,'k')
hold on
```

```
plotorbit(a,e,tsA,tsD,0,'r')
plotorbit(Re,0,0,2*pi,0,'g')
plot(-2*a*e,0,'gX','markersize',30)
xlim(([-3.25 3.25]-.8)*1e4)
ylim(([-3.25 3.25])*1e4)
xlabel('$\hat{e}$ Position, km')
ylabel('$\hat{p}$ Position, km')
title('Energy Transfer - TOF = 3.6 Hours - Joseph Le')
set(gcf,'position',[0,0,1500,1500])
plotpos(a,e,tsD,'r',0,1)
plotpos(a,e,tsA,'r',0,1)
plotpos(a,e,0,'b',0,.000001)
```




```
th1 = 0;
w = th1 - tsD, w_deg = rad2deg(w)
```

```
w = -2.0610
w_deg = -118.0855
```

Part e)

```
ts1 = acos(3*Re/r1), ts1_deg = rad2deg(ts1)
```

```
ts1 = 0.3218
ts1_deg = 18.4349
```

```
iCr1 = [cos(ts1) -sin(ts1);sin(ts1) cos(ts1)]
```

```
iCr1 = 2×2
    0.9487   -0.3162
    0.3162    0.9487
```

```
v1_R = [0 sqrt(mu/r1)]'
```

```
v1_R = 2×1
         0
    4.4455
```

```
v1_I = [iCr1 * v1_R;0]
```

```
v1_I = 3×1
   -1.4058
    4.2174
         0
```

```
iCrD = findDCM(ts1,inc,th1)
```

```
iCrD = 3×3
    0.9487   -0.2765    0.1535
    0.3162    0.8294   -0.4605
         0    0.4854    0.8743
```

```
vD_I = iCrD * vD * [sin(gammaD); cos(gammaD); 0]
```

```
vD_I = 3×1
    0.7123
    3.8923
    1.9249
```

```
dv_I = vD_I-v1_I
```

```
dv_I = 3×1
    2.1181
   -0.3251
    1.9249
```

```
dvmag = norm(dv_I)
```

```
dvmag = 2.8805
```

```
Vhat = v1_I/norm(v1_I)
```

```
Vhat = 3×1
   -0.3162
    0.9487
```

```
        0
```

```
Nhat = cross(r1_I,v1_I)/norm(cross(r1_I,v1_I))
```

```
Nhat = 3×1
     0
     0
     1
```

```
Bhat = cross(Vhat,Nhat)
```

```
Bhat = 3×1
    0.9487
    0.3162
         0
```

```
iCv1 = [Vhat,Bhat,Nhat];
vCi1 = iCv1';
dv_VBN = vCi1*dv_I
```

```
dv_VBN = 3×1
   -0.9782
    1.9066
    1.9249
```

```
betaD = asin(dv_VBN(2)/dvmag)
```

```
betaD = 0.7233
```

```
alphaD = acos(dot(v1_I(1:2),dv_I(1:2))/norm(v1_I)/norm(dv_I(1:2))), alphaD_deg = rad2de
```

```
alphaD = 2.0448
alphaD_deg = 117.1604
```

```
betaD = acos(dv_VBN(1)/dvmag/cos(alphaD)), betaD_deg = rad2deg(betaD)
```

```
betaD = 0.7319
betaD_deg = 41.9335
```

Part f)

```
f = (1-r2/p * (1-cos(tsA-tsD)))
```

```
f = -0.5800
```

```
g = rA*rD/sqrt(mu*p)*sin(tsA-tsD)
```

```
g = 6.6268e+03
```

```
fdot = (dot([rA;0],vD*[sin(gammaD);cos(gammaD)])/p/rA * (1-cos(tsA-tsD)) - 1/rD*sqrt(mu
```

```
fdot = -1.3236e-04
```

```
gdot = (1-rD/p*(1-cos(tsA-tsD)))
```

```
gdot = -0.2118
```

```
r2_I = f*r1_I+g*vD_I
```

```
r2_I = 3×1
10^4 ×
   -0.6378
    2.2094
    1.2756
```

```
v2_I = fdot*r1_I+gdot*vD_I
```

```
v2_I = 3×1
   -2.6835
   -1.6687
   -0.4077
```