Problem 1

```
addpath(genpath(fileparts(which('pathfile.m'))))
interr = 'latex';
% interr = 'none';
set(groot,'defaulttextinterpreter',interr);
set(groot, 'defaultAxesTickLabelInterpreter',interr);
set(groot, 'defaultLegendInterpreter',interr);
mu = 132712440017.99;
AU = 149598000;
```

Part a)

```
r1 = 1.83*AU, lam1 = deg2rad(43.7), del1 = deg2rad(33.9)
```

```
r1 = 273764340
lam1 = 0.7627
del1 = 0.5917
```

```
r2 = 3.15*AU, lam2 = deg2rad(62.4), del2 = deg2rad(48.2)
```

```
r2 = 471233700
lam2 = 1.0891
del2 = 0.8412
```

```
r1_I = r1*[cos(lam1)*cos(del1);sin(lam1)*cos(del1);sin(del1)]
```

```
r1_I = 3×1
10^8 ×
    1.6428
    1.5699
    1.5269
```

```
r2_I = r2*[cos(lam2)*cos(del2);sin(lam2)*cos(del2);sin(del2)]
```

```
r2_I = 3×1
10^8 ×
    1.4552
    2.7835
    3.5129
```

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

```
hhat = 3×1
    0.2869
   -0.8051
    0.5191
```

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

```
inc = 1.0250
inc_deg = 58.7283
```

```
% om = pi-asin(hhat(1)/sin(inc))
om = acos(-hhat(2)/sin(inc)), om_deg = rad2deg(om)
```

```
om = 0.3423
om_deg = 19.6138
```

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

```
TA = 0.3487
TA_deg = 19.9802
```

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

```
c = 2.3350e+08
```

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

```
s = 4.8925e+08
```

```
amin = s/2
```

```
amin = 2.4463e+08
```

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

```
alphamin = 3.1416
```

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

```
betamin = 1.6163
```

```
TOFmin = sqrt(amin^3/mu) * ((alphamin-sin(alphamin))-(betamin-sin(betamin)))
```

```
TOFmin = 2.6511e+07
```

```
TOFmin_month = TOFmin/24/3600/30
```

```
TOFmin_month = 10.2282
```

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

```
TOFpar = 8.7110e+06
```

```
TOfpar_month = TOFpar/24/3600/30
```

```
TOfpar_month = 3.3607
```

```
TOF = 3.26*30*24*3600
```

```
TOF = 8449920
```

```
[a,alpha,beta] = bisection(TOF,amin,c,mu,'1H',.01)
```

```
a = -3.0128e+09
alpha = 0.5624
beta = 0.4092
```

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

```
p = 2.1897e+08
```

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

```
e = 1.0357
```

```
dH = alpha-beta
```

```
dH = 0.1533
```

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

```
rp = 1.0757e+08
```

```
ts1 = acos(1/e * (p/r1 - 1)), tsD_deg = rad2deg(ts1)
```

```
ts1 = 1.7653
tsD_deg = 101.1423
```

```
ts2 = ts1+TA, tsA_deg = rad2deg(ts2)
```

```
ts2 = 2.1140
tsA_deg = 121.1225
```

```
f = 1-abs(a)/r1 * (cosh(dH)-1)
```

```
f = 0.8705
```

```
g = r2*r1/sqrt(mu*p)*sin(TA)
```

```
g = 8.1772e+06
```

```
v1_I = (r2_I-f*r1_I)/g
```

```
v1_I = 3×1
    0.3080
   17.3284
   26.7062
```

```
romhat = [cos(om);sin(om);0]
```

```
romhat = 3×1
    0.9420
    0.3357
         0
```

```
th1 = acos(dot(romhat,r1_I/r1)), th1_deg = rad2deg(th1)
```

```
th1 = 0.7109
th1_deg = 40.7342
```

```
w = th1 - ts1, w_deg = rad2deg(w)
```

```
w = -1.0543
w_deg = -60.4081
```

```
fdot = -sqrt(mu*abs(a))/r1/r2 * sinh(dH)
```

```
fdot = -2.3851e-08
```

```
gdot = 1-abs(a)/r2*(cosh(dH)-1)
```

```
gdot = 0.9247
```

```
v2_I = fdot*r1_I + gdot*v1_I
```

```
v2_I = 3×1
   -3.6334
   12.2801
   21.0547
```

```
H1 = conicanom(ts1,e)
```

```
H1 = 0.3249
```

```
H1 = conicanom(ts2,e)
```

```
H1 = 0.4782
```

```
[TOF2,dt1,dt2] = timeofflight(ts1,ts2,a,e,r1,mu)
```

```
TOF2 = 8.4499e+06
dt1 = 7.9694e+06
dt2 = 1.6419e+07
```

```
dt1_month = dt1/3600/24/30
```

```
dt1_month = 3.0746
```

```
dt2_month = dt2/3600/24/30
```

```
dt2_month = 6.3346
```

```
TOFmonth2 = dt2_month-dt1_month
```

```
TOFmonth2 = 3.2600
```

```
tsinf = acos(-1/e)
```

```
tsinf = 2.8783
```

```
plotorbit(a,e,-tsinf*.8,tsinf*.8,0,'k')
hold on
plotorbit(a,e,ts1,ts2,0,'b')
plotpos(a,e,ts1,'r',0,1)
plotpos(a,e,ts2,'r',0,1)
plotpos(a,e,w,'k',0,.000001) % AOP
```

```
v1 = sqrt(mu*(2/r1-1/a))
```

```
v1 = 31.8369
```

```
v2 = sqrt(mu*(2/r2-1/a))
```

```
v2 = 24.6435
```

```
gamma1 = acos(sqrt(mu*p)/r1/v1), gamma1_deg = rad2deg(gamma1)
```

```
gamma1 = 0.9040
gamma1_deg = 51.7930
```

```
gamma2 = acos(sqrt(mu*p)/r2/v2), gamma2_deg = rad2deg(gamma2)
```

```
gamma2 = 1.0881
gamma2_deg = 62.3412
```

```
iCr1 = [cos(ts1) -sin(ts1); sin(ts1) cos(ts1)];
iCr2 = [cos(ts2) -sin(ts2); sin(ts2) cos(ts2)];
v1_ep = iCr1*[sin(gamma1);cos(gamma1)];
v2_ep = iCr2*[sin(gamma2);cos(gamma2)];
plotvel(a,e,ts1,v1_ep,'g',0,0,3e8)
plotvel(a,e,ts2,v2_ep,'m',0,0,3e8)
xlim([-7 7]*1e8)
ylim([-7 7]*1e8)
title('Chronos Trajectory in Orbital Plane')
xlabel('$\hat{e}$ Position, km')
ylabel('$\hat{p}$ Position, km')
```