Problem 3

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

AU = 1.496e+8;
R_E = 6378.1363;
R_V = 6051.9;
R_M = 2439.7;
mu_E = 398600.4415;
mu_V = 324858.59882646;
mu_M = 22032.080486418;
mu_S = 132712440017.99;
a_E = 149597898.0000;
a_V = 108207284.0000;
a_M = 57909101.0000;
```

Part a)

```
launch = 2453221.0000000;
E_encounter = 2453585.0000000;
V_encounter1 = 2454033.0000000;
M_encounter1 = 2454480.0000000;
MOI = 2455639.0000000;
% i
TOF = E_encounter-launch
```

```
TOF = 364
```

```
% ii
TOF = V_encounter1 - E_encounter
```

```
TOF = 448
```

```
% iii
TOF = M_encounter1 - launch
```

```
TOF = 1259
```

```
% iiii
TOF = MOI - launch
```

```
TOF = 2418
```

```
clear launch TOF E_encounter V_encounter1 M_encounter1 MOI
```

Part b)

```
a_T = 0.8*AU
```

```
a_T = 119680000
```

```
a_M/a_T
```

```
ans = 0.4839
```

```
r1_mag = a_E
```

```
r1_mag = 149597898
```

```
r2_mag = a_V
```

```
r2_mag = 108207284
```

```
e_T = a_E/a_T - 1
```

```
e_T = 0.2500
```

```
ta_1 = pi
```

```
ta_1 = 3.1416
```

```
ta_2 = posangle(-acos(1/e_T * (a_T * (1-e_T^2)/r2_mag - 1))), ta_2_deg = rad2deg(ta_2)
```

```
ta_2 = 4.8606
ta_2_deg = 278.4904
```

```
E1 = conicanom(ta_1,e_T)
```

```
E1 = 3.1416
```

```
E2 = conicanom(ta_2,e_T)
```

```
E2 = 5.1059
```

```
[TOF,dt1,dt2] = timeofflight(ta_1,ta_2,a_T,e_T,r1_mag,mu_S)
```

```
TOF = 7.8896e+06
dt1 = 1.1291e+07
dt2 = 1.9180e+07
```

```
TOF_day = TOF/3600/24
```

```
TOF_day = 91.3148
```

```
v_V_mag = sqrt(mu_S/a_V)
```

```
v_V_mag = 35.0209
```

```
v2_0_mag = sqrt(mu_S*(2/r2_mag - 1/a_T))
```

```
v2_0_mag = 36.6611
```

```
iCr = [cos(ta_2) -sin(ta_2); sin(ta_2) cos(ta_2)]
```

```
iCr = 2×2
```

```
   0.1476    0.9890
  -0.9890    0.1476
```

```
h_T = sqrt(mu_S * a_T*(1-e_T^2))
```

```
h_T = 3.8588e+09
```

```
gamma2_0 = -acos(h_T/r2_mag/v2_0_mag), gamma2_0_deg = rad2deg(gamma2_0)
```

```
gamma2_0 = -0.2341
gamma2_0_deg = -13.4113
```

```
v2_0_R = v2_0_mag * [sin(gamma2_0);cos(gamma2_0)]
```

```
v2_0_R = 2×1
   -8.5032
   35.6614
```

```
v2_0 = iCr * v2_0_R
```

```
v2_0 = 2×1
   34.0151
   13.6752
```

```
v_V = iCr * v_V_mag * [sin(0);cos(0)]
```

```
v_V = 2×1
   34.6371
    5.1706
```

```
v_inf_0 = v2_0 - v_V
```

```
v_inf_0 = 2×1
   -0.6220
    8.5045
```

```
v_inf_mag = norm(v_inf_0)
```

```
v_inf_mag = 8.5273
```

```
a_h = -mu_V/v_inf_mag^2
```

```
a_h = -4.4676e+03
```

```
e_h = 1-1.5*R_V/a_h
```

```
e_h = 3.0319
```

```
delta = 2*(asin(1/e_h)), delta_deg = rad2deg(delta)
```

```
delta = 0.6722
delta_deg = 38.5162
```

```
eta = pi-asin(v2_0_mag/v_inf_mag * sin(abs(gamma2_0))),eta_deg = rad2deg(eta)
```

```
eta = 1.6460
eta_deg = 94.3072
```

```
zeta = asin(v_V_mag/v_inf_mag*sin(abs(gamma2_0))),zeta_deg = rad2deg(zeta)
```

```
zeta = 1.2616
zeta_deg = 72.2815
```

```
zeta+eta+abs(gamma2_0)
```

```
ans = 3.1416
```

```
v2_n_mag = sqrt(v_V_mag^2 + v_inf_mag^2 - 2*v_V_mag*v_inf_mag*cos(eta-delta))
```

```
v2_n_mag = 31.0385
```

```
gamma2_n = -asin(v_inf_mag/v2_n_mag * sin(eta-delta)),gamma2_n_deg = rad2deg(gamma2_n)
```

```
gamma2_n = -0.2292
gamma2_n_deg = -13.1323
```

```
v2_n_R = v2_n_mag*[sin(gamma2_n);cos(gamma2_n)]
```

```
v2_n_R = 2×1
   -7.0520
   30.2268
```

```
v2_n = iCr * v2_n_R
```

```
v2_n = 2×1
   28.8543
   11.4375
```

```
dv_eq_R = v2_n_R - v2_0_R
```

```
dv_eq_R = 2×1
    1.4512
   -5.4346
```

```
dv_eq = v2_n-v2_0
```

```
dv_eq = 2×1
   -5.1607
   -2.2377
```

```
dv_eq_mag = norm(dv_eq)
```

```
dv_eq_mag = 5.6250
```

```
rvs = r2_mag*v2_n_mag^2/mu_S
```

```
rvs = 0.7855
```

```
e_n = sqrt((rvs-1)^2*cos(gamma2_n)^2+sin(gamma2_n)^2)
```

```
e_n = 0.3086
```

```
ta2_n = pi+atan((rvs*cos(gamma2_n)*sin(gamma2_n))/(rvs*cos(gamma2_n)^2-1)), ta2_n_deg =
```

```
ta2_n = 3.7398
ta2_n_deg = 214.2721
```

```
a_n = r2_mag*(1+e_n*cos(ta2_n))/(1-e_n^2)
```

```
a_n = 8.9096e+07
```

```
ra_n = a_n*(1+e_n)
```

```
ra_n = 1.1659e+08
```

```
rp_n = a_n*(1-e_n)
```

```
rp_n = 6.1598e+07
```

```
period = 2*pi/sqrt(mu_S/a_n^3),period_day = period/3600/24
```

```
period = 1.4505e+07
period_day = 167.8801
```

```
dw = ta2_n - ta_2,dw_deg = rad2deg(dw)
```

```
dw = -1.1208
dw_deg = -64.2184
```

Part d)

```
beta = asin(v2_n_mag/dv_eq_mag*sin(gamma2_n-gamma2_0))
```

```
beta = 0.0269
```

```
beta_deg = rad2deg(beta)
```

```
beta_deg = 1.5396
```

```
alpha = pi-beta, alpha_deg = rad2deg(alpha)
```

```
alpha = 3.1147
alpha_deg = 178.4604
```

Part e)

```
% plotorbit(ai,ei,ths1,ths2,rotate)
% plotvel(a,e,ths,v_R,color,dvoption,angle,scale)
plotorbit(a_T,e_T,0,2*pi,0) % old
hold on
plotorbit(a_n,e_n,0,2*pi,dw) % new
xlim([-1.7 1.2]*1e8)
axis equal
xlim([-2 1.4]*1e8)
plotpos(a_T,e_T,0,'k',0,0) % rp old
plotpos(a_T,e_T,pi,'k',0,0) % ra old
plotpos(a_n,e_n,0,'k',dw,0) % rp new
plotpos(a_n,e_n,pi,'k',dw,0) % ra new
plotvel(a_T,e_T,ta_2,v2_0,'r',0,0,2e6)
```

```
plotvel(a_n,e_n,ta2_n,v2_n,'b',0,dw,2e6)
set(gcf,'position',[0,0,1200,1200])
plotorbit(a_M,0,0,2*pi,0)
```