Problem 1

```
interr = 'latex';
% interr = 'none';
set(groot,'defaulttextinterpreter',interr);
set(groot, 'defaultAxesTickLabelInterpreter',interr);
set(groot, 'defaultLegendInterpreter',interr);
```

Part a)

```
rm = 3397; % km
alt_p = 500; % km
rp = rm + alt_p; % km
vinf = 2.64; % km/s
mu = 42828.314258067;
a = -mu/vinf^2
```

```
a = -6.1450e+03
```

```
energy = -mu/(2*a)
```

```
energy = 3.4848
```

```
e = 1 - rp/a
```

```
e = 1.6342
```

```
h = sqrt(-mu^2/(2*energy)*(1-e^2))
```

```
h = 2.0968e+04
```

```
p = a*(1-e^2)
```

```
p = 1.0265e+04
```

```
delta = 2*asin(1/e)
```

```
delta = 1.3170
```

```
delta_deg = rad2deg(delta)
```

```
delta_deg = 75.4585
```

```
thinf = delta/2 + pi/2
```

```
thinf = 2.2293
```

```
thinf_deg = rad2deg(thinf)
```

```
thinf_deg = 127.7292
```

Part b)

```
b = abs(a)*sqrt(e^2-1)
```

```
b = 7.9423e+03
```

```
b2 = sin((pi-delta)/2)*(rp+abs(a))
```

```
b2 = 7.9423e+03
```

```
thb = -acos(b/(rp+abs(a)))
```

```
thb = -0.6585
```

```
thb_deg = rad2deg(thb)
```

```
thb_deg = -37.7292
```

```
rb_mag = p/(1+e*cos(thb))
```

```
rb_mag = 4.4778e+03
```

```
rb = rb_mag*[cos(thb),sin(thb)]'
```

```
rb = 2×1
10^3 ×
    3.5416
   -2.7401
```

```
vb_mag = sqrt(2*(energy+mu/rb_mag))
```

```
vb_mag = 5.1087
```

```
thb_dot = h/rb_mag^2
```

```
thb_dot = 0.0010
```

```
gamma = -acos(rb_mag*thb_dot/vb_mag)
```

```
gamma = -0.4113
```

```
gamma_deg = rad2deg(gamma)
```

```
gamma_deg = -23.5672
```

```
vb = vb_mag*[sin(gamma), cos(gamma)]
```

```
vb = 1×2
   -2.0426    4.6826
```

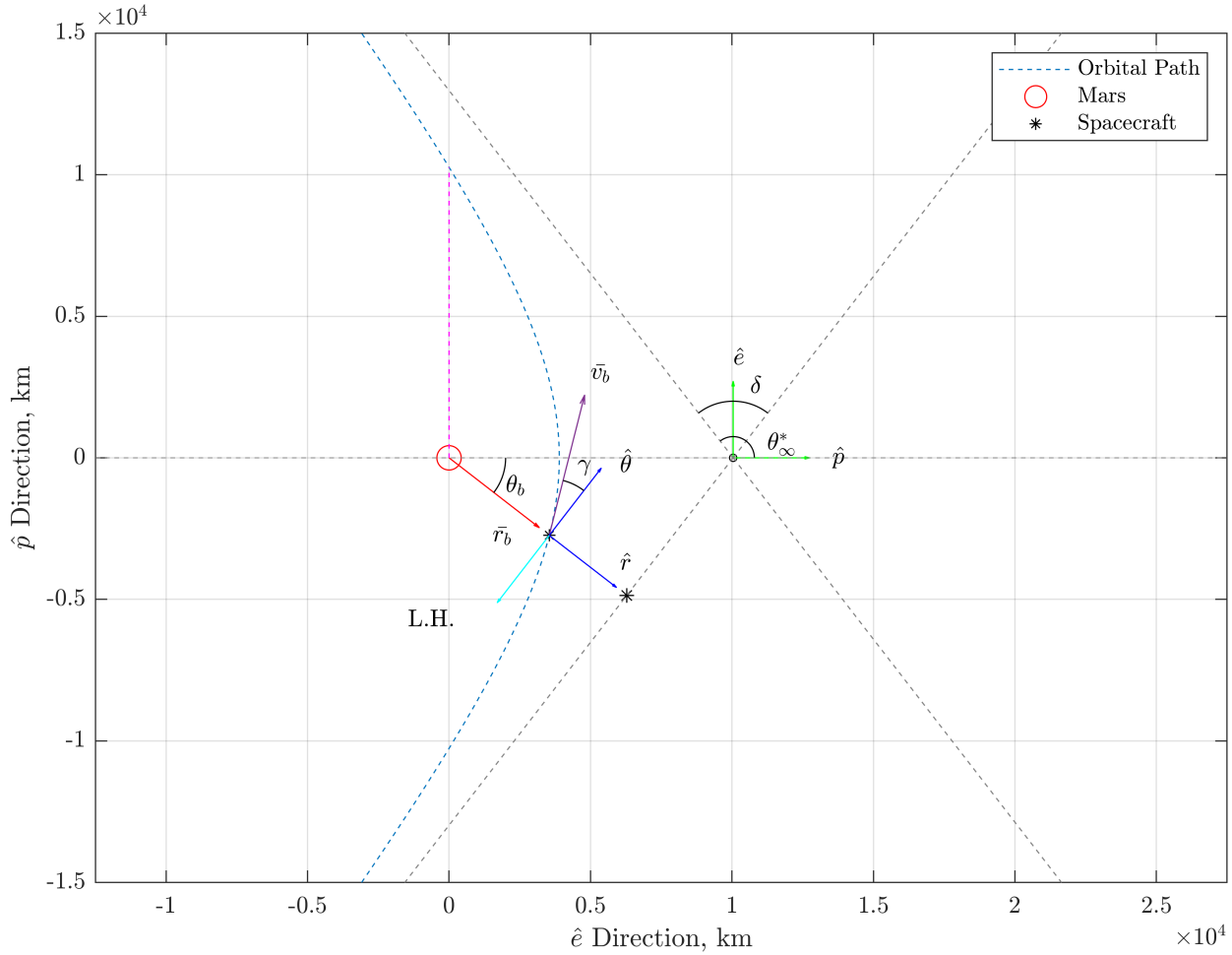
```
RCI = [cos(thb) sin(thb); -sin(thb) cos(thb)];
ICR = RCI.';

vb_xy = ICR*vb'
```

```
vb_xy = 2×1
    1.2499
    4.9534
```

```
% Plotting
th_plot = linspace(-thinf*.8,thinf*.8,2^10);
r_plot = p./(1+e*cos(th_plot));
r_xy = [r_plot.*cos(th_plot); r_plot.*sin(th_plot)]';
```

```
plot(r_xy(:,1),r_xy(:,2),'--','MarkerSize',.1) % plot orbital path % -(rp+abs(a))
hold on

% Plotting Points
plot(0,0,'ro','MarkerSize',10) % Mars
plot(rb(1),rb(2),'k*','markersize',5) % spacecraft
plot(rb(1)*b/rb_mag,rb(2)*b/rb_mag,'k*') % aim point
plot(rp+abs(a),0,'ko','markersize',3) % center

% r and v
quiver(rb(1),rb(2),'r') % rb vector
quiver(rb(1),rb(2),vb_xy(1),vb_xy(2),1e3,'color','#7E2F8E') % vb vector

% Unit Vectors
quiver(rb(1),rb(2),cos(thb),sin(thb),3e3,'b')% r hat
quiver(rb(1),rb(2),-sin(thb),cos(thb),3e3,'b')% th hat
quiver(rb(1),rb(2),sin(thb),-cos(thb),3e3,'c')% local horizon
quiver(rp+abs(a),0,3e3,0,'g')
quiver(rp+abs(a),0,0,3e3,'g')

% Hyperbolic Constraint Lines
beta = (pi-delta)/2;
plot([rp+abs(a), cos(beta)*1e10],[0 sin(beta)*1e10],'--','color','#828282')
plot([rp+abs(a), cos(beta)*1e10],-[0 sin(beta)*1e10],'--','color','#828282')
plot([rp+abs(a), -cos(beta)*1e10],[0 sin(beta)*1e10],'--','color','#828282')
plot([rp+abs(a), -cos(beta)*1e10],-[0 sin(beta)*1e10],'--','color','#828282')
yline(0,'--','color','#828282')
plot([0,0],[0,p],'--','Color','#FF00FF') % semi-latus rectum
plotcircle(rp+abs(a),0,beta,pi-beta,2e3) % delta
plotcircle(rb(1),rb(2),thb+pi/2,thb+pi/2-gamma,2e3) % gamma
plotcircle(0,0,0,thb,2e3) % thb
plotcircle(rp+abs(a),0,0,thinf,.75e3)

% Labels
text(rp+abs(a),.35e4,'$\hat{e}$') % ehat
text(rp+abs(a)+.35e4,0,'$\hat{p}$') % phat
text(rb(1)+.25e4,rb(2)+.25e4,'$\hat{\theta}$') % thhat
text(rb(1)-.5e4,rb(2)-.3e4,'L.H.') % lh
text(rb(1)+.25e4,rb(2)-.1e4,'$\hat{r}$') % rhat
text(rp+abs(a)+.6e3,.25e4,'$\delta$') % delta
text(rp+abs(a)+1.2e3,.5e3,'$\theta^{*}_{\infty}$') % thinf
text(rb(1)+.1e4,rb(2)+.25e4,'$\gamma$') % gamma
text(.2e4,-1e3,'$\theta_{b}$') % thb
text(rb(1)-2e3,rb(2),'$\bar{r_{b}}$')
text(.5e4,.3e4,'$\bar{v_{b}}$')

% Plot Parameters
grid on
axis equal
xmin = -2e4; xmax = 2e4; ymin = -1.5e4; ymax = 1.5e4;
xlim([xmin xmax]+.75e4); ylim([ymin ymax])
set(gcf,'position',[0,0,800,800])
xlabel('$\hat{e}$ Direction, km')
ylabel('$\hat{p}$ Direction, km')
```

```
legend('Orbital Path','Mars','Spacecraft','')
```



Part c)

```
gmatreport = importdata('problem1report_edited.txt');
% gmatreport = importdata('problem1report.txt');
gmatdata = num2cell(gmatreport.data);
gmatheaders = gmatreport.colheaders;
cell2table(gmatdata(17:23,:),'variablenames',gmatheaders)
```

ans = 7×8 table

	TA	RMAG	VMAG	Energy	VelPeriapsis	SemilatusRectum	FPA
1	301.8819	5.5100e+03	4.7450	3.4848	5.3804	1.0266e+04	126.6787
2	308.6407	5.0810e+03	4.8814	3.4848	5.3804	1.0266e+04	122.2830
3	315.8028	4.7273e+03	5.0089	3.4848	5.3804	1.0266e+04	117.6818
4	323.2364	4.4457e+03	5.1222	3.4848	5.3804	1.0266e+04	112.9560
5	331.0483	4.2247e+03	5.2197	3.4848	5.3804	1.0266e+04	108.0326
6	339.7497	4.0526e+03	5.3015	3.4848	5.3804	1.0266e+04	102.5870
7	348.5092	3.9462e+03	5.3550	3.4848	5.3804	1.0266e+04	97.1330

Part d)

```
vp = sqrt(mu*(2/rp - 1/a))
```

```
vp = 5.3805
```

```
vcp = sqrt(mu/rp)
```

```
vcp = 3.3151
```

```
dv = vcp - vp
```

```
dv = -2.0654
```

Function 1: plot circle

```
function plotcircle(x0,y0,theta0,thetaf,r)
th = linspace(theta0,thetaf,2^10);
x = r*cos(th)+x0;
y = r*sin(th)+y0;
plot(x,y,'k')
end
```