3.2

$r\_earth := 6378.14km$ $\quad mu\_earth := 398600\frac{km^3}{s^2}$ $\quad ec := .00132$ $\quad h\_p := 917km$

$r\_p := r\_earth + h\_p$ $\quad r\_p = 7.295\times 10^3 km$

$r\_a := r\_p\cdot\frac{(-1 - ec)}{(ec - 1)}$ $\quad r\_a = 7.314\times 10^3 km$

$a := .5\cdot(r\_p + r\_a)$ $\quad a = 7.305\times 10^3 km$

$P := 2\cdot\frac{\pi}{\left(\frac{mu\_earth}{a^3}\right)^{.5}}$ $\quad P = 1.726hr$

$V\_p := \left(2\cdot\frac{mu\_earth}{r\_p} + \frac{-mu\_earth}{a}\right)^{.5}$ $\quad V\_p = 7.397\frac{km}{s}$

3.4

$h\_p := 250km$ $\quad P := 3.1hr$ $\quad mu\_venus := 324858.8\frac{km^3}{s^2}$ $\quad r\_venus := 6051.8km$

$r\_p := h\_p + r\_venus$ $\quad r\_p = 6.302\times 10^3 km$

$a := \left[mu\_venus\cdot\left(\frac{P}{2\cdot\pi}\right)^2\right]^{\left(\frac{1}{3}\right)}$ $\quad a = 1.008\times 10^4 km$

$ec := 1 - \frac{r\_p}{a}$ $\quad ec = 0.375$

$r\_a := (ec + 1)\cdot a$ $\quad r\_a = 1.386\times 10^4 km$

$h\_a := r\_a - r\_venus$ $\quad h\_a = 7.811\times 10^3 km$

3.6

$V\_inf := 10 \frac{km}{s}$ $b := 10000km$ $mu\_venus = 3.249 \times 10^{5} \frac{km^{3}}{s^{2}}$

$$r\_p := \left[\left(\frac{mu\_venus}{V\_inf^{2}}\right)^{2} + b^{2}\right]^{.5} - \frac{mu\_venus}{V\_inf^{2}}$$

$r\_p = 7.266 \times 10^{3} km$

3.8

approach

$a\_a := 17110km$ $ec\_a := 1.3690$

$r\_pa := a\_a \cdot (ec\_a - 1)$

$r\_pa = 6.314 \times 10^{3} km$

$$V\_a := \left[\left(2 \cdot \frac{mu\_venus}{r\_pa}\right) + \left(\frac{mu\_venus}{a\_a}\right)\right]^{.5}$$

$V\_a = 11.041 \frac{km}{s}$

orbit

$a\_o := 10424.1km$ $ec\_o := .39433$

$r\_po := r\_pa$

$$V\_o := \left[\left(2 \cdot \frac{mu\_venus}{r\_po}\right) - \left(\frac{mu\_venus}{a\_o}\right)\right]^{.5}$$

$V\_o = 8.47 \frac{km}{s}$

$dV := V\_o - V\_a$

$dV = -2.57 \frac{km}{s}$

3.10

circ_orbit elliptical_orbit

$r := 15000km$ $h\_p := 500km$ $r\_a := 22000km$

change of direction at r=15000km

$r\_p := h\_p + r\_earth$ $r\_p = 6.878 \times 10^{3} km$

$a := .5 \cdot (r\_p + r\_a)$ $a = 1.444 \times 10^{4} km$

$V\_circ := \left(\frac{mu\_earth}{r}\right)^{.5}$ $V\_circ = 5.155 \frac{km}{s}$

$V\_ellipse := \left(2 \cdot \frac{mu\_earth}{r} - \frac{mu\_earth}{a}\right)^{.5}$ $V\_ellipse = 5.054 \frac{km}{s}$

$ec := \frac{(r\_a - r\_p)}{r\_a + r\_p}$ $ec = 0.524$

$\theta := acos\left[\frac{-1}{ec} + r\_p \cdot \frac{(1 + ec)}{r \cdot ec}\right]$ $\theta = 2.184 rad$

$\gamma := atan\left(ec \cdot \frac{\sin(\theta)}{1 + ec \cdot \cos(\theta)}\right)$ $\gamma = 0.55 rad$

$dV := \left(V\_circ^{2} + V\_ellipse^{2} - 2 \cdot V\_circ \cdot V\_ellipse \cdot \cos(\gamma)\right)^{.5}$ $dV = 2.773 \frac{km}{s}$

elliptical transfer from circle to apoasis of ellipse

$a\_t := .5 \cdot (r + r\_a)$ $a\_t = 1.85 \times 10^{4} km$

$v\_ptrans := \left(2 \cdot \frac{mu\_earth}{r} + \frac{-mu\_earth}{a\_t}\right)^{.5}$ $v\_ptrans = 5.621 \frac{km}{s}$

$v\_atrans := \left(2 \cdot \frac{mu\_earth}{r\_a} + \frac{-mu\_earth}{a\_t}\right)^{.5}$ $v\_atrans = 3.833 \frac{km}{s}$

$v\_afinal := \left(2 \cdot \frac{mu\_earth}{r\_a} + \frac{-mu\_earth}{a}\right)^{.5}$ $v\_afinal = 2.938 \frac{km}{s}$

$dV\_ell := |v\_afinal - v\_atrans| + |v\_ptrans - V\_circ|$ $dV\_ell = 1.362 \frac{km}{s}$

it is cheaper to do an elliptical transfer

3.14

$r\_earth = 6.378 \times 10^3\,km$ $\quad La\_ETR := 28.5deg$ $\quad La\_Ples := 62.9deg$

$h\_park := 280km$ $\quad i := 63deg$

$$V\_equator := 2\cdot\pi\cdot\frac{r\_earth}{1day} \qquad V\_equator = 463.831\,m\,s^{-1}$$

$$V\_ETR := 2\cdot\pi\cdot r\_earth\cdot\frac{\cos(La\_ETR)}{1day} \qquad V\_ETR = 407.623\,m\,s^{-1}$$

$$V\_Ples := 2\cdot\pi\cdot r\_earth\cdot\frac{\cos(La\_Ples)}{1day} \qquad V\_Ples = 211.296\,m\,s^{-1}$$

earth to parking orbit

$$V\_park := \left(\frac{mu\_earth}{h\_park + r\_earth}\right)^{.5} \qquad V\_park = 7.737\,\frac{km}{s}$$

$$dV1 := V\_park - V\_Ples \qquad dV1 = 7.526\,\frac{km}{s}$$

parking to Hohmann ellipse

$$r\_p := h\_park + r\_earth$$

$$r\_a := 42164.2km$$

$$a := .5\cdot(r\_p + r\_a) \qquad a = 2.441 \times 10^4\,km$$

$$V\_p := \left(2\cdot\frac{mu\_earth}{r\_p} - \frac{mu\_earth}{a}\right)^{.5} \qquad V\_p = 10.169\,\frac{km}{s}$$

$$dV2 := V\_p - V\_park \qquad dV2 = 2.431\,\frac{km}{s}$$

combined plane change and circulation

$$V\_a := \left(2\cdot\frac{mu\_earth}{r\_a} - \frac{mu\_earth}{a}\right)^{.5} \qquad V\_a = 1.606\,\frac{km}{s}$$

$$V\_GEO := \left(\frac{mu\_earth}{r\_a}\right)^{.5} \qquad V\_GEO = 3.075\,\frac{km}{s}$$

$$dV3 := \left(V\_a^2 + V\_GEO^2 - 2\cdot V\_a\cdot V\_GEO\cdot\cos(i)\right)^{.5} \qquad dV3 = 2.748\,\frac{km}{s}$$

$$dV\_tot := dV1 + dV2 + dV3 \qquad dV\_tot = 12.705\,\frac{km}{s}$$