Assignment-4

1) Transferring from orbit 1 to intermediate orbit-

$$-\frac{GM_e m}{2r_1} + \frac{1}{2}mv_1^2 = -\frac{GM_e m}{r_1+r_2}$$

$$\Rightarrow 2\left(\frac{GM_e}{2r} - \frac{GM_e}{r_1+r_2}\right) = v^2$$

$$\Rightarrow v_1 = \sqrt{\frac{GM_e}{r_1}}\sqrt{\frac{r_2}{r_1+r_2}} = v_1$$

$$\Rightarrow \Delta v_1 = \sqrt{\frac{GM_e}{r_1}}\left(\sqrt{\frac{r_2}{r_1+r_2}} - 1\right)$$

Before transferring from intermediate orbit to orbit 2

$$-\frac{GM_e m}{r_1+r_2} + \frac{1}{2}mv_2^2 = -\frac{GM_e m}{2r_2}$$

$$v_2^2 = 2\left(\frac{GM_e}{r_1+r_2} - \frac{GM_e}{2r_2}\right)$$

$$\Rightarrow \Delta v_2 = \sqrt{\frac{GM_e}{r_2}}\left(1 - \sqrt{\frac{2r_2}{r_1+r_2}}\right)$$

ii) Geostationary (35800 km) $\longrightarrow$ Graveyard Orbit (36050 km)

Putting the values, ~~we get~~,

$r_1 = 35800 + R_e$
$= 42200$ km

$r_2 = 36050 + R_e$
$= 42450$ km.

Putting them we get.

~~$(\Delta V_{tot})_{GO} = \Delta V$~~ $\Delta V_{GO} = \Delta v_1 + \Delta v_2 = 9.07$ m/s

i) Geostationary $\longrightarrow$ Low Earth Orbit (400 km)

$r_1 = 35800 + R_e = 42200$ km

$r_2 = 400 + R_e = 6800$ km

Putting them we get.

$\Delta V_{LEO} = \Delta v_1 + \Delta v_2 = -3856$ m/s

As $\Delta V_{GO} < \Delta V_{LEO}$

That's why we ~~can~~ should prefer to ~~transfer~~ dispose off the satellite in the graveyard orbit.

2) $M_1 = 1.989 \times 10^{30}$ kg $\quad R_{SE} = 1.5 \times 10^{11}$ m

$M_2 = 5.972 \times 10^{24}$ kg

The Lagrange points for Sun-Earth system are,

→ $L_1 = \left(R\left[1 - \left(\frac{M_2/M_1}{3}\right)^{1/3}\right], 0\right)$

$$R\left[1 - \left(\frac{M_2/M_1}{3}\right)^{1/3}\right] = 1.5 \times 10^{11}\left[1 - \left(\frac{\frac{5.972 \times 10^{24}}{1.989 \times 10^{30}}}{3}\right)^{1/3}\right]$$

$$= 1.485 \times 10^{11}$$

$L_1 = \{(1.485 \times 10^{11}), 0\}$

→ $L_2 = \left(R\left[1 + \left(\frac{M_2/M_1}{3}\right)^{1/3}\right], 0\right) = (1.5 \times 10^{11}[1 + 0.01], 0)$

$= [(1.515 \times 10^{11}), 0)$

→ $L_3 = \left(-R\left[1 + \frac{5}{12}\frac{M_2}{M_1}\right], 0\right) = [(-1.5 \times 10^{11}), 0]$

$$-R\left[1 + \frac{5}{12}\frac{M_2}{M}\right] = -1.5 \times 10^{11}\left[1 + \frac{5}{12} \times 3 \times 10^{-6}\right] = -1.5 \times 10^{11}$$

3) Initially the satellite is on another direction but when it comes closer to Jupiter. Because of its gravity it changes is speed as well as direction.