Basic Orbital Manoeuvre Problems

Problem No. 01

A satellite is put in a **circular** orbit at 400 km altitude. Determine 'Δv' **needed** to raise apogee altitude to **36000 km,** keeping perigee same.

$$R_E = 6378km; \quad \mu = 3.986 \times 10^{14} m^3 / s^2$$

Solution No. 01

The **solution** for velocity impulse is as **given** below.

$$r_0 = 6778km; \quad r_1 = 42378km; \quad a_{elp} = \frac{6778 + 42378}{2} = 24578km$$

$$v_0 = \sqrt{\frac{\mu}{r_0}} = 7{,}668.63m/s; \quad e = \frac{r_1 - r_0}{r_1 + r_0} = 0.724$$

$$v_{elp} = \sqrt{\frac{2\mu r_1}{r_0\left(r_1 + r_0\right)}} = 10069.7m/s; \quad \Delta v = 2401.0m/s$$

Problem No. 02

A satellite is in an **elliptic** orbit with perigee altitude of **200 km** & apogee altitude of **20000 km**. Determine 'Δv' to **raise** the apogee altitude to **286,000 km**. (R_E = 6378 km, $\mu = 3.986\times10^{14}\ m^3/s^2$).

Solution No. 02

Apogee altitude raising solution is as **follows.**

$$a_{elp1} = 16478km; \quad a_{elp2} = 149478km$$

$$v_{p1} = \sqrt{\left(\frac{3.986\times10^{14}\times26378}{16478\times6.578\times10^{6}}\right)} = 9849m/s$$

$$\Delta v = \sqrt{\frac{3.986\times10^{14}}{6.578\times10^{6}}}\times\left[\sqrt{\frac{292378}{149478}}-\sqrt{\frac{26378}{16478}}\right] = 1038m/s$$

Problem No. 03

A satellite is in an **elliptical orbit** with perigee radius of 6930 km & apogee radius of 8586 km. Determine 'Δv' at **apogee** to circularize the orbit. ($\mu = 3.986 \times 10^{14}$ m^3/s^2).

Solution No. 03

Circularization solution is as given **below**.

$$a_{elp} = \frac{6930 + 8568}{2} = 7,760km$$

$$v_{elp-a} = \sqrt{\frac{3.986 \times 10^{14} \times 6.93}{8.568 \times 7.76 \times 10^{6}}} = 6,445m/s$$

$$v_{cir} = \sqrt{\frac{3.986 \times 10^{14}}{8.568 \times 10^{6}}} = 6,820m/s; \quad \Delta v = 374m/s$$