MOOC@TU9

Week 9 - The Rise of Small Satellites

How much power do our solar panels need to generate?

T = *orbit period*
T_d = *time in sunlight (day)*
T_e = *eclipse time (night)*
P_e, P_d = *power consumption (eclipse/ day)*
P_{SA} = *power generation by solar array*
η_e/η_d = *efficiency of the power subsystem (eclipse / day)*
$\eta_e = 0.65$
$\eta_d = 0.85$

R = *earth radius* = $6378km$
h = *orbit height* = $500km$
$GM = 398\,600\,\frac{km^3}{s^2}$

$$T = 2\pi\sqrt{\frac{(R+h)^3}{GM}} = 2\pi\sqrt{\frac{(6378km+500km)^3}{398\,600\,\frac{km^3}{s^2}}} = 2\pi\sqrt{816,298.92\,s^2}$$
$$= 2\pi \cdot 903.5\,s = 5677\,s$$

$$T_e = \frac{T}{\pi}arcsin(\frac{R}{R+h}) = \frac{5677\,s}{\pi}arcsin(\frac{6378}{6878}) = 2145\,s$$

$$T_d = T - T_e = 5677s - 2145s = 3532s$$

$$P_{SA} = \frac{1}{T_d}(\frac{P_e T_e}{\eta_e} + \frac{P_d T_d}{\eta_d}) = \frac{1}{3532s}(\frac{P_e \cdot 2145s}{0.65} + \frac{P_d \cdot 3532s}{0.85})$$

$$= \frac{P_e \cdot 3300 + P_d \cdot 4155}{3532} = 0.934 \cdot P_e + 1.176 \cdot P_d$$