The angular velocity of the flywheel as a function of time (and thus a function of **n** (the ivt ratio from zero to $\mathbf{n_e}$) is equal to the initial momentum of the flywheel ($\mathbf{I_{fwa}*\omega_{fwai}}$) divided by the total inertia as seen by the flywheel ($\mathbf{I_{fwa}}+(\mathbf{n^2*I_{fwb}})$):

(24) $$\omega_{fwa}(t) := \frac{I_{fwa}\cdot\omega_{fwai}}{I_{fwa} + n(t)^2\cdot I_{fwb}} \qquad \omega_{fwb}(t) := n(t)\cdot\omega_{fwa}(t)$$

The angular velocity of flywheel A & B per eq. 24:

$$\omega_{fwa}(t_e) = 5.04 \times 10^3\cdot rpm \qquad \omega_{fwb}(t_e) = 377.974\cdot rpm$$

The angular momentum as a function of time:

$$L_{fwa}(t) := I_{fwa}\cdot\omega_{fwa}(t) \qquad L_{fwb}(t) := I_{fwb}\cdot\omega_{fwb}(t)$$

The torque is the effective change in momentum divided by the time taken to make the change:

$$\tau_{fwa}(t) := I_{fwa}\cdot\left(\frac{\omega_{fwa}(t) - \omega_{fwai}}{t}\right) \qquad \tau_{fwb}(t) := I_{fwb}\cdot\left(\frac{\omega_{fwb}(t) - \omega_{fwbi}}{t}\right)$$

Show that at any time (x) during the period t_i to t_e momentum is conserved is conserved ($L_{fwai} = L_{fwa}(t)+L_{fwb}(t)+L_{sa}(t)$ where L_{sa} is the momentum imparted to the gear housing:

$$x := 10\cdot s \qquad n(x) = 0.054$$

$$\tau_{fwa}(x) = -819.7\cdot N\cdot m \qquad \tau_{fwb}(x) = 1.53 \times 10^4\cdot N\cdot m$$

Torque applied to the IVT housing and thus the body of the satellite:

$$\tau_{sa}(t) := -\tau_{fwa}(t) - \tau_{fwb}(t) \qquad \tau_{sa}(x) = -1.448 \times 10^4\cdot N\cdot m$$

The momentum of flywheels a & B at time x:

$$L_{fwa}(x) = 1.632 \times 10^4\,\frac{m^2\cdot kg}{s} \qquad L_{fwb}(x) = 1.53 \times 10^5\,\frac{m^2\cdot kg}{s}$$

The momentum of the satellite at time x:

$$L_{sa}(t) := \tau_{sa}(t)\cdot t \qquad L_{sa}(x) = -1.448 \times 10^5\,\frac{m^2\cdot kg}{s}$$

Proof that that the total ending momentum is equal to the initial momentum of flywheel A:

$$L_{tot}(t) := L_{fwa}(t) + L_{fwb}(t) + L_{sa}(t) \qquad L_{tot}(x) = 2.452 \times 10^4\,\frac{m^2\cdot kg}{s}$$

$$L_{fwai} := I_{fwa}\cdot\omega_{fwai} \qquad L_{fwai} = 2.452 \times 10^4\,\frac{m^2\cdot kg}{s}$$

Choose any value for $\mathbf{I_{sa}}$ - this will result in a specific angular velocity of $\boldsymbol{\omega_{sa}}$ and will change $\mathbf{EK_{sa}}$ by its square. Thus, kinetic energy varys and is not conserved

$$I_{sa} := 10^{11} \cdot m^2 \cdot kg$$

$$\omega_{sa}(t) := \frac{L_{sa}(t)}{I_{sa}} \qquad \omega_{sa}(x) = -1.383 \times 10^{-5} \cdot rpm$$

$$x := 14 \cdot s \qquad Ek_{fwa}(t) := .5 \cdot I_{fwa} \cdot \omega_{fwa}(t)^2 \qquad Ek_{fwa}(x) = 3.261 \times 10^6 \cdot J$$

$$Ek_{fwb}(t) := .5 \cdot I_{fwb} \cdot \omega_{fwb}(t)^2 \qquad Ek_{fwb}(x) = 3.209 \times 10^6 \cdot J$$

$$Ek_{sa}(t) := .5 \cdot I_{sa} \cdot \omega_{sa}(t)^2 \qquad Ek_{sa}(x) = 0.113 \cdot J$$

$$Ek_{tot}(t) := Ek_{fwa}(t) + Ek_{fwb}(t) + Ek_{sa}(t) \qquad Ek_{tot}(x) = 6.47 \times 10^6 \cdot J$$

$$Ek_i := Ek_{fwa}\left(t_i\right) \qquad Ek_i = 1.284 \times 10^7 \cdot J$$

The graph shows exactly what should be expected: As the ratio of the IVT changes from 0 to .075 (which is more conventionally 1/ratio which would make it infinity to 13.33), the angular velocity of flywheel A decreases from 10,000 rpm to 5040 rpm and its energy decrease by the square of velocity while flywheel B increases from 0 to 375 rpm and its energy increases likewise. The total energy will always be less than the initial energy. The energy of the satellite spin is negligible