① RPM requirement

Lead Screw Length : $L = 300mm$

We decided to allocate 20 seconds for the charger to be moved to the desired hight.

Max height : 60 cm

Min height : 37 cm (from project guideline)

$\therefore \Delta h = 60 - 37 = 23$ cm

$\therefore$ pulses to travel 23 cm :

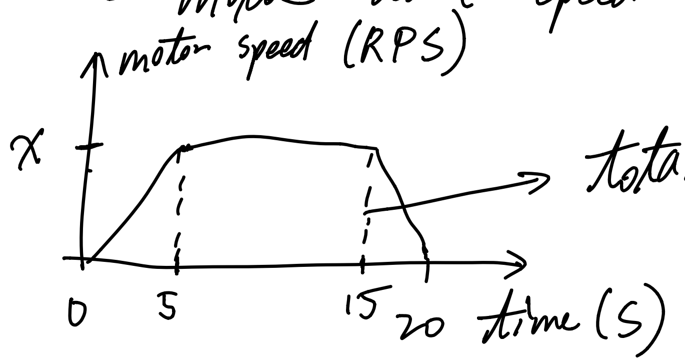
$$23cm \times \frac{16 \text{ rev}}{3cm} = 122.7 \text{ rev}$$

(from lead screw measurement)

$$\frac{122.7 \text{ rev}}{20 \text{ s}} = 6.13 \text{ RPS} = 368 \text{ RPM}$$

on average.

$\because$ motors don't speed up instantaneously :



total 122.7 rev required

∴ assume acceleration = deacceleration
assume acceleration time = 5s.

∴ Area under trapazoid:

$$\frac{10s+20s}{2} \cdot x = 122.7 \text{ rev}$$

$$x = 8.18 \text{ RPS} = 490.8 \text{ RPM}$$

↓ max motor speed

② Torque requirement

Rotor inertia: 82.00 g cm^2

Lead screw inertia:

Approximate as cylinder $I = \frac{1}{2} M R^2$

$M = 104 \text{ g}$

$R = \frac{0.500}{2}$ inch $= \frac{1.27}{2}$ cm $= 0.635$ cm.

$$I = \frac{1}{2} \times 104 g \cdot (0.635 \text{ cm})^2$$

$$= 21.0 \text{ g cm}^2$$

Since lead screw from Myhal doesn't have data sheet with it, use pay load of 0.005 in^2 to convert linear load into inertia.

↓ 5 times 0.001, which is the pay load of another type of lead screw.

Estimated load on the lead screw:

$m = 5 \text{kg}$

$$I_{load} = 5 \text{kg} \times (0.005 \text{ in}^2) = 0.16129 \text{ kg cm}^2$$

$= 161.29\ g\ cm^2$

$\therefore$ total inertia $= 161.29 + 21 + 82 = 264.29\ g\ cm^2$

Torque $= T_{run} + T_{accel}$

$$T_{accel} = I \times \left(\frac{\Delta w}{\Delta t}\right) \rightarrow \text{angular velocity}$$

$$= 264.29\ g\ cm^2 \times \frac{491\ RPM}{5\ s}$$

$$= 264.29\ g\ cm^2 \times \frac{8.18\ rev/s}{5\ s}$$

$$= 432.55\ \frac{g\ cm^2\ rev}{s^2}$$

$$= 2717.82\ \frac{g\ cm^2}{s^2}$$

$\therefore T_{accel} = 2.72\ \frac{kg\ cm^2}{s^2} = 2.72 \times 10^{-4}\ \frac{kg\ m^2}{s^2} = 2.72 \times 10^{-4}\ Nm$

$= 0.0272\ Ncm$

$T_{run} = T_{friction} + T_{gravity} + \cancel{T_{ext}} \rightarrow 0.$

due to limited information on lead screw, we ignore friction.

$T_{gravity} = 5\ kg \times 9.80\ m/s^2 = 49\ N$

every 16 revolution $\rightarrow$ 3 cm.

For 16 revolutions, Energy $= 49\ N \times 3\ cm = 1.47\ J.$

also $E = \text{Torque} \cdot \Delta\theta$

$$\therefore\ T_{gravity} = \frac{E}{\Delta\theta} = \frac{1.47J}{16\,rev} = \frac{1.47J}{100.53\,rad}$$

$$= 0.0146\ Nm = 1.46\ Ncm.$$

$\therefore$ Neglecting friction, torque required:

$$T = 1.46 + 0.0272 = 1.49\ Ncm.$$

Assume friction amplifies required torque $\times 10$

$$T_{total} = 1.49 \times 10 = 14.9\ Ncm$$