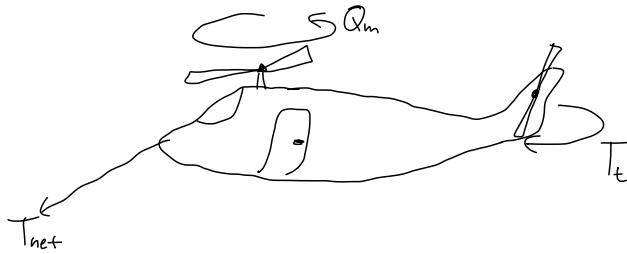


Formulas:

Forces Body Diagram



Main Rotor Lift At Hover (T_m):

$$T_m = mg \quad (\text{mass} \cdot \text{gravity}) [\text{N}]$$

Main Rotor Area (A_m):

$$A_m = 2\pi R_m^2 \quad (R \rightarrow \text{blade radius}) [\text{m}^2]$$

Main Rotor Power (P_m):

$$P_m = \frac{\sqrt{T_m^3}}{\sqrt{2\rho A_m}} \quad (P \rightarrow \text{density}, A_m \rightarrow \text{Area}) [\text{W}]$$

Main Rotor Torque (Q_m):

$$Q_m = \frac{P_m}{\omega_m} \quad (P_m \rightarrow \text{Power}, \omega_m \rightarrow \text{angular Velocity}) [\text{N} \cdot \text{m}]$$

Tail Rotor Thrust (T_t)

$$T_t = \frac{Q_m}{L_t} \quad (L_t \rightarrow \text{Length of tail}) [\text{N}]$$

Tail Rotor Power (P_t):

$$P_t = T_t \cdot V_t \quad (V_t \rightarrow \text{Nominal Velocity}) [\text{W}]$$

Main Propeller Calculations:

Assuming $m = 750 \text{ g}$ (50g below recommended maximum weight)

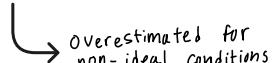
$$T_m = (0.75)(9.81) = 7.36 \text{ N} \quad (\text{Thrust generated by main rotor})$$

Our blades are 180mm each, so:

$$A_m = \pi(0.18)^2 = 0.102 \text{ m}^2 \quad (\text{Area of the rotor blades})$$

Assuming an air density of 1.262 kg/m^3 , the ideal hover power is:

$$P_{m,i} = \frac{(7.36)^{3/2}}{\sqrt{2}(1.262)(0.102)} = 40 \text{ W} \longrightarrow P_m = (P_{m,i})(2.5) = 100 \text{ W}$$


overestimated for
non-ideal conditions

our motor's KV is 380 rpm/V, so using a 4s (14.8V) battery,
the rpm output is:

$$RPM_{no-load} = (380)(14.8) = 5624 \xrightarrow{25\% \text{ reduction to account for load}} RPM_{loaded} = (RPM_{no-load})(75\%) = 4200$$

At 4200 rpm, our angular velocity is:

$$\omega_m = (RPM)\left(\frac{2\pi}{60}\right) = 440 \text{ rad/sec}$$

So the torque generated by our main motor is:

$$Q_m = \frac{100}{440} = 0.23 \text{ N} \cdot \text{m}$$

Tail Propeller Calculations:

We chose a 0.25m tail boom, so our required tail moment is:

$T_t = \frac{0.23}{0.25} = 0.92N$. Because our input is harmonic, T_t will fluctuate So ideally we want $\sim 2N$ of thrust capacity

Our tail blades are 60mm each, so the tail rotor area is:
 $A_t = \pi(0.06)^2 = 0.0113m^2$

So the ideal Power required for our motor is:

$$P_t = \frac{(T_t)^{3/2}}{\sqrt{2\rho A_t}} = \frac{2^{3/2}}{\sqrt{2(1.262)(0.0113)}} = 16.7W \xrightarrow[1.8X \text{ to account for drag and energy losses}]{} P_{t,real} \approx 30W$$