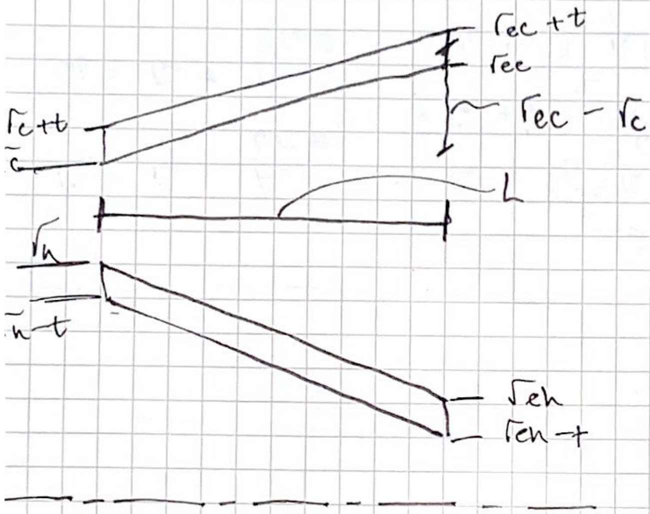
DIFFUSER VOLUME

$(r_c + r_n)(r_c - r_n)$

$r_c^2 - \cancel{r_c r_n + r_n r_c} - r_n^2$

$$L = \frac{r_c - r_n}{DF}$$



$$r_{ec} = r_c(1+\sigma) + r_n(1-\sigma)$$

$$= r_n + \frac{A_e}{4 r_m \pi} \qquad A_e = \pi(r_c^2 - r_n^2)\sigma$$

$$= \frac{r_c + r_n}{2} + \frac{\cancel{2\pi}(r_c^2 - r_n^2)\sigma}{2\cancel{4}(r_c + r_n)\cancel{\pi}}$$

$$= \frac{r_c + r_n}{2} + \frac{\cancel{(r_c + r_n)}(r_c - r_n)\sigma}{2\cancel{(r_c + r_n)}}$$

$$= \frac{r_c + r_n + (r_c - r_n)\sigma}{2}$$

$$= \frac{r_c + r_c\sigma + r_n - r_n\sigma}{2}$$

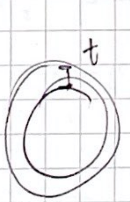
$$= \frac{r_c(1+\sigma) + r_n(1-\sigma)}{2}$$

$$r_{ec} - r_c = \frac{r_c(1+\sigma) + r_n(1-\sigma)}{2} - r_c$$

$$= \frac{r_c(1+\sigma) - 2r_c + r_n(1-\sigma)}{2}$$

$$= \frac{r_c(\sigma - 1) + r_n(1-\sigma)}{2}$$

$$\therefore L_{diff} = \mathrm{sqrt}\left[\left(\frac{r_c - r_n}{Df}\right)^2 + \left(\frac{r_c(\sigma-1) + r_n(1-\sigma)}{2}\right)^2\right] \times t \times 2\pi$$



$$dA = t\, dl \cdot \sqrt{L_{diff}^2 - (r_{ec} - r_c)^2}$$

$$dl^2 = dl_{diff}^2 - (r_{ec} - r_c)^2$$

$$\frac{1}{3} h \pi r^2$$

$$\frac{L}{r_{ec} - r_c} \cdot \overbrace{r_{ec}}^{r_{ec} - t} = h$$

$$r^2 = r_{ec}^2 \sim (r_{ec} - t)^2$$

$$\therefore A = \frac{L r_{ec}^3 \pi}{3(r_{ec} - r_c)} - \frac{L(r_{ec} - t)^3 \pi}{3(r_{ec} - r_c)} - \left[\frac{L}{(r_{ec} - r_c)} \cdot r_{ec} - h\right]\pi$$

$$h_1^* = \frac{L}{r_{ec} - r_c} \cdot (r_{ec} + t) \qquad h_2^* = \frac{L}{r_{ec} - r_c} \cdot (r_{ec})$$

$$\therefore V = \frac{h_1 \pi (r_{ec} + t)^2}{3} - \frac{h_2 \pi (r_{ec})^2}{3} - (h_1 - L)\pi(r_c + t)$$

$$= \frac{h_1 \pi (r_{ec} + t)^2}{3} - \frac{(h_1 - L)\pi (r_c + t)^2}{3} - \left[\frac{h_2 \pi r_{ec}^2}{3} - \frac{(h_2 - t)\pi r_c^2}{3}\right]$$

$$h_1 = \frac{L}{r_{ec} - r_c} \cdot (r_{ec} + t)$$

$$h_2 = \frac{L}{r_{ec} - r_c} \cdot (r_{ec})$$

$$V = \cancel{K \pi (r_{ec} + t)^2}$$

$$V_{case} = \frac{\pi}{3}\left[h_1 (r_{ec} + t)^2 - (h_1 - L)(r_c + t)^2 - h_2 r_{ec}^2 + (h_2 - L) r_c^2\right]$$

$$V_{hub} = \frac{\pi}{3}\left[h_1 r_h^2 - (h_1 - L)(r_{eh})^2 - h_2 (r_h - t)^2 + (h_2 - L)(r_{eh} - t)^2\right]$$

COVER LETTER

UPDATE CV

$$k_v V = rpm \qquad V = 14.8\ V$$

$$V = \frac{rpm}{kv}$$

$$P = IV$$

$$\therefore I = \frac{P}{V} = \frac{P k_v}{rpm}$$

Battery $\rightarrow$ $\boxed{\text{Control}}$ $\rightarrow$ $\boxed{\text{Motor}}$ $\rightarrow$ $\boxed{\text{Propulsor}}$

$P_E = VI$ $\rightarrow$ $\frac{\cancel{\text{rpm}}}{\cancel{\text{rpm}}}$ $\frac{\text{rpm}}{kv}$

$= \text{inlet} \times \text{duct} \times \text{blades}$

P_E

$\therefore P = \eta_c \eta_m \eta_p P_E$

$P = \eta_T VI = \eta_T \frac{\text{rpm}}{kv} I = P$

$\frac{\text{rpm}}{kv} I = \eta_T P_E$

$I = \frac{kv P}{\eta_T \text{rpm}}$

$\cancel{I = \eta_T \frac{P_E kv}{\text{rpm}}}$

$P_T = \eta_T P_E$

$= \eta_T \frac{\text{rpm}}{kv} I$

$\therefore I = \frac{P_T kv}{\eta_T \text{rpm}}$

Prop - RPM Power characteristics
APC props with known calibration
- Same prop diameter
-

Sigma limit due to geometric constraints of diffuser becoming cone.

$\sigma \Rightarrow \quad r_{eh} = 0$

$\therefore 0.5\left[r_c(1-\sigma) + r_h(1+\sigma)\right] = 0 \qquad M_t = \sqrt{2\sigma}$

$r_c(\sigma - 1) = r_h(1+\sigma)$

$\sigma(r_c - r_h) = r_h + r_c$

$\sigma_{max} = \frac{r_h + r_c}{r_c - r_h} = \frac{\phi^2}{2\psi} \qquad \therefore \psi = \frac{\phi^2}{2\sigma_{max}} =$

C_p

$\rightarrow$ Update MESH SECTION.

$\rightarrow$ Need to relate ϕ, ψ, r_h, r_c, u

$$\phi^2 = \frac{T_T \sigma}{\rho A_x U^2} \qquad \varphi = \frac{T_T}{2\rho A_x U^2 \sigma}$$

// Equate σ ~~$\frac{\phi^2 \rho A_x U^2}{\sigma} = \varphi 2\rho A_x$~~

$$\frac{\phi^2 \rho A_x U^2}{T_T} = \frac{T_T}{2\rho A_x U^2 \varphi}$$

$$T_T^2 = 2\varphi\phi^2\rho^2 A_x^2 U^4$$

$$T_T = \phi\sqrt{2\varphi}\,\rho A_x U^2 \qquad T_T = M$$

$$= \phi\sqrt{2\varphi}\,\rho_a \pi (r_t^2 - r_h^2)\cdot \Omega^2 \left(\frac{r_t + r_h}{4}\right)^2$$

$$M = \rho_p (V_D + V_1 + V_c)$$

$$fn(r_t, r_h, t, \phi, \rho).$$

4A2 Computational Fluid Dynamics

flow_guess

Exit velocity & ρ given isentropic flow with known inlet & exit area.

$p_{0in} = p_{0out}$ A_e = allow (ni)

$T_{0in} = T_{0out}$

$p_e = p_{down}$

$\therefore$ At exit $\left(\frac{p_e}{p_{0out}}\right) = \left(1 + \frac{\gamma-1}{2} M^2\right)^{-\gamma/\gamma-1}$

$$\therefore M^2 = \frac{2}{\gamma-1}\left(\left(\frac{p_{0out}}{p_e}\right)^{\gamma-1/\gamma} - 1\right)$$

$$M = \mathrm{sqrt}(\mathrm{ans})$$

Further $\frac{T}{T_0} = \left(1 + \frac{\gamma-1}{2} M^2\right)^{-1}$

$$T = T_0\left(1 + \frac{\gamma-1}{2} M^2\right)^{-1}$$

Assuming uniform flow

$$\dot{m} = \rho A V$$

$$\therefore V = M\sqrt{\gamma R T}$$

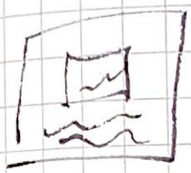
Density (Ideal gas)

$$\frac{p_e}{\rho} = RT_e \qquad \therefore \rho = \frac{p_e}{RT_e}$$

$$\dot{m} = \frac{p_e}{RT}\cdot A \cdot M\sqrt{\gamma R T_e} = p_e A M \sqrt{\frac{\gamma}{RT}}$$

Presentation Chat

~~Line In~~ Physics



Line In	Diagram	Physics	Line Out
Introduce	Explain whats on it	Explain why	Sum-up.

1. Analytical model. Slide 11
   - Have details on backup slide only

Intro to section

- Model to static thrust
- Slides 19/20 become bullet points in an introduction.

2. Slide 12 is intro slide to 2nd Q.
   - More like future work.

- Slide 14, more interested in outputs as in poster

Combine 13 + 14

4 - Animation to replace drone ~~pic~~ with schematic
+ explain where M_F comes from.

Modular

- Made to compare engines

14 - 2 problems

Control I've used ....

Measurement I've developed...

$T = k_1 \sin\phi$

$\Omega = k_v V$

② . 4 slides

12, 13, 14 & results of payload & power.

① ~~Dees~~ 11 → 4

?

No control over M_F for ideal prop.

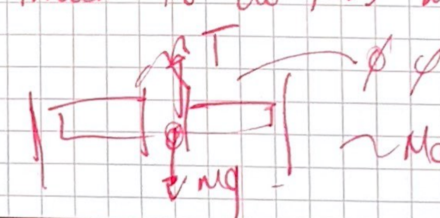
With ducted fan, diffuser adds DoF hence $M_F = fn(\sigma)$.

How do I design it to give good M_F?.

Then picture slide with ONLY

New fixed ....

To close problem need to match weight to thrust. To do this mass model.



~ Mags =