# Helicopter Engineering H.W. No. 3

Due: 06/03/2020 (Wed) 6:00PM

Problem #1 Consider two tandem (non-overlapping) rotors, each having thrust T/2 and disk area $A_1$, with total power

$$P_1 = P_{i1} + P_{01}$$

where P - denotes total power, $P_i$ - denotes induced power and $P_0$ - denotes profile power. Next consider two co-axial rotors, each having thrust T/2 and disk area $A_2$, with total power

$$P_2 = P_{i2} + P_{02}$$

Furthermore, assume small vertical separations between the co-axial rotors.

If $P_{02}/P_{i2} = P_{01}/P_{i1}$ and $V_{t2} = V_{t1}$

and $\sigma_2 = \sigma_1$, find $A_2/A_1$ and $P_2/P_1$.

Where $V_t$ - is the tip speed and $\sigma$ is the blade solidity.

Problem #2

(a) Use the simple energy method to calculate the rotor horsepower required at $\mu$ = 0.10; 0.20; and 0.3 for the following helicopter in forward flight.

| | | |
|---|---|---|
| W | = | 3000 lb |
| R | = | 15 ft |
| $\sigma$ | = | 0.075 |
| $C_{d0}$ | = | 0.012 |
| $\Omega R$ | = | 600 ft/sec |
| $f$ | = | 8 $ft_2$ (equivalent flat plate area) |
| $\rho$ | = | 0.00238 slug∫$ft^3$ |

use $\dfrac{v}{\Omega R} \approx \dfrac{C_T}{2\mu}$, $\mu \geq 0.1$

and include the radial flow component in the calculation of the profile power.

(b) Calculate rate of climb at the same $\mu$'s given that the available power is 150% of the hover power required (main rotor).

(c) Calculate rate of descent (minimum) at same $\mu$'s (power off).

(d) Calculate rate of descent at the same $\mu$'s given that available power is 50% of hover power required (main rotor). What phenomenon might limit this type of operation?