헬리콥터 고급이론 과제물 1번

제출기한: 4월 6일 (금)

1.

Suppose a hypothetical helicopter, somewhat similar to the Bell Jet Ranger, with the following data:

weight	W	= 3000 lb	(1.333×10^4 N)
rotor radius	R	= 16 ft	(4.88 m)
rotor disk area	A	$\equiv \pi R^2 = 804 ft^2$	($74.7\ m^2$)
rotor tip speed	V_t	= 700 ft/sec	(213 m/sec)
rotor blade chord	c	= 1 ft (=constant)	(0.3048 m)
number of blades	N	= 2	
blade profile drag coefficient	c_{d_0}	= 0.01	
lift-curve slope	a	= 6	

Take atmospheric density and pressure at sea level, respectively, as

$\rho = 0.00238$ slug/ft^3 (1.226 kg/m^3), $p_\infty = 2116$ lb/ft^2 (1.013×10^5 N/m^2)

Assume that the inflow is uniform $\lambda_H = \frac{v_H}{\Omega R}$

(a) Find the non-dimensional pressure change $\Delta p/p_\infty$ across the rotor disk.

(b) Find the value w of the induced velocity far below the rotor, according to the momentum theory.

(c) Find the thrust coefficient C_T.

(d) Find the (local) lift coefficient c_l *at* $r = \frac{1}{2}R$.

(e) Find the (local) blade pitch angle θ at $r = \frac{1}{2}R$, in degrees.

(f) Find the ratio C_{P_0} / C_{P_i} of the profile-power coefficient to the induced-power coefficient.

2.

For a hovering helicopter with coaxial rotors, estimate the hovering horsepower required and the pitch settings for the rotor blades if

c	=	25"
R	=	185"
b	=	2 blades per rotor
T	=	6500 lb (total); RPM = 300
θ	=	θ_t /(r/R) (ideal twist)
ρ	=	0.00238 slugs/ft^3
C_{d0}	=	0.012 (independent of α)
a	=	5.73 (per radian)

Neglect slipstream contractions in calculating rotor interference effects, but discuss qualitatively its influence on required θ. You can also assume that each rotor produces 3250 lbs of thrust.

3. Explain the reason why the plot shown in Lecture Note p. 36f appears in a decreasing fashion for v/v_H when it is in either vertical climb ($V/v_H > 0.$) or unpowered descent ($V/v_H < -2.$) regimes?