FUNDAMENTAL AERO EQUATIONS TO MEMORIZE

The equations given here are basic tools which will be used numerous times in Aero 315. You should commit them to memory **as soon as they are covered in the syllabus**. These equations are fair game for quizzes, etc. at any time after they are covered in class. Of course, you will also be expected to know and understand them for exams.

GR #1

$P = \rho R T$ Perfect Gas Law (2.1)

$q = \frac{1}{2} \rho V^2$ Dynamic Pressure (3.5)

$\dot{m} = \rho A V$ 1-D Mass Flow (3.1)

$\rho_1 A_1 V_1 = \rho_2 A_2 V_2$ 1-D Compressible Continuity Equation (3.2)

$P_0 = P_1 + \frac{1}{2}\rho V_1^2 = P_2 + \frac{1}{2}\rho V_2^2$ Bernoulli's Equation (3.4)

Memorize the airspeed where compressible flow effects must be considered (330 ft/s or 100 m/s)

$L = C_L q S$ Lift as a function of lift coefficient (4.4, 3.21)

$D = C_D q S$ Drag as a function of drag coefficient (4.5, 3.22)

$M = C_M q S \bar{c}$ Pitching moment as a function of pitching moment coefficient (3.24)

$AR = \dfrac{b^2}{S}$ Aspect Ratio (4.2)

taper ratio $\lambda = \dfrac{C_{tip}}{C_{root}}$

GR #2

$M = \dfrac{V}{a}$ $V = Ma = M\sqrt{\gamma R T}$ Mach Number (3.34)

profile drag coefficient → $C_D = C_{D_0} + k\,\underset{\text{induced drag}}{C_L^2}$ Aircraft drag polar (4.15)

parasite drag coeff. (zero-lift drag coeff.)

$k = \dfrac{1}{\pi e_0 AR}$ Aircraft "drag due to lift" factor (4.16)

$P = T V$ Power relationship to thrust (5.24)

$R = E V$ Range relationship to endurance (5.37)

Memorize the relationship between parasite and induced drag for all major performance objectives as well as where these relationships occur on the Thrust and Power charts.

Bernoulli

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2 = P_0$$

Steady
Streamlined
Inviscid
Incompressible

Body forces negligible

$$P_s = \frac{dh}{dt} + \frac{V}{g}\frac{dV}{dt}$$

1) $\quad \dfrac{dh}{dt} = P_s - \dfrac{V}{g}\dfrac{dV}{dt}$

2) $\quad \dfrac{V}{g}\dfrac{dV}{dt} = P_s - \dfrac{dh}{dt}$

$\quad\rightarrow \dfrac{dV}{dt} = \left(P_s - \dfrac{dh}{dt}\right)\dfrac{g}{V}$