MMAE 410 – Aircraft Flight Mechanics
Computer Homework Assignment 1

Due September 18, 2017

(Please provide your code, figures and numerical results clearly)

1. Given the aerodynamic and inertial properties of C-172: Thrust $T = 360$ lb (assume constant), reference area $S = 175.5$ ft^2, runway slope and dry rolling friction $\mu_r = 0.025$ and $\varphi = 0^o$, weight $W = 2,450$ lb, gravitational acceleration $g = 32.2$ ft/s^2, sea-level air density $\rho = 0.00238$ slug/ft^3, zero-lift drag coefficient $C_{D_0} = 0.02$, lift-induced drag coefficient $K = 0.085$, maximum lift coefficient $C_{L_{\max}} = 1.78$, write a code in MATLAB to simulate the ground roll flight phase of C-172 using a numerical ODE (Ordinary Differential Equation) solver (e.g., ODE23) and obtain ground roll distance S_g in existence of

   a) no wind,

   b) a 15 ft/s head wind,

   c) a 15 ft/s tail wind.

   (Hint: The states for a straight ground roll is speed and ground roll distance.)

2. Given the properties of a paper airplane glider: reference area $S = 0.017$ m^2, aspect ratio $AR = 0.86$, Oswald efficiency factor $e = 0.9$, mass $m = 0.003$ kg, gravity $g = 9.8$ m/s^2, air density $\rho = 1.225$ kg/m^3, zero-lift drag coefficient $C_{D_0} = 0.02$, initial height $h = 2$ m, assume $(L/D)_{\max}$, assuming glide at $(L/D)_{\max}$, simulate and plot the trajectory of the paper glider (range vs height) when it starts with

   a) an equilibrium initial conditions,

   b) a zero initial flight path angle and 5 m/s initial speed.

   c) Iterate your simulation with higher initial speeds and zero initial flight path angle and find the approximate speed that starts a loop in the trajectory.

   d) Compare and discuss the results.

   Hint: Treat paper glider as point-mass. With no thrust the pitch/vertical plane motion of airplane will be governed by four differential equation:

$$\dot{V} = \frac{1}{m}\left[-C_D \frac{1}{2}\rho S V^2 - W\sin\gamma\right]$$

$$\dot{\gamma} = \frac{1}{mV}\left[C_L \frac{1}{2}\rho S V^2 - W\cos\gamma\right]$$

$$\dot{h} = V\sin\gamma$$

$$\dot{r} = V\cos\gamma$$

where speed V, flight path angle γ, height h, and range r are called longitudinal states.