<u>**In the Name of Allah**</u>

Flight Dynamics II ***HW #1*** ***Winter 2021*** ***Due 20/01/1400***

1- A vehicle has the following velocity components with respect to the Earth centered inertial frame:

$u^i(t) = u_O^i + a_x^i t;\quad v^i(t) = a_y^i t;\quad w^i(t) = 0$

Assuming $u_O^i = 100\,ft/s$, $a_x^i = 25\,ft/s^2$, $a_y^i = 50\,ft/s^2$, determine and plot the position and velocity of the vehicle for 100 Seconds in the Earth-Fixed $x_E y_E z_E$, as well as the navigation (or NED, $x_n y_n z_n$) frames. Assume that the vehicle is initially (t=0) located on the equator with $(\lambda = 0, L = 0),\ where\ \lambda = Longitude\ and\ L = Lattitude$.

2- An aircraft model is being tested in a low-speed wind tunnel at an angle of attack of 20 deg, sideslip of 10 deg and bank angle of 10 deg. An inertial strain gage balance is used to measure the aerodynamic forces acting on the model, which gives components of forces in the body axes system. The measurements reflect $F_x = 21.7\,lb$, $F_y = -33.0\,lb$, and $F_z = -91\,lb$. Determine the body to tunnel transformation matrix T^{wb} as well as the lift, drag and side forces acting on the model.

3- With no thrust, the point-mass planar **longitudinal motion** of a glider is governed by four differential equations:

$$\dot{V} = -C_D \frac{1}{2}\rho V^2 S/m - g\sin\gamma$$
$$\dot{\gamma} = \frac{1}{V}(C_L \frac{1}{2}\rho V^2 S/m - g\cos\gamma)$$
$$\dot{h} = V\sin\gamma$$
$$\dot{R} = V\cos\gamma$$

where h and R are height (altitude) and ground range. The constant airspeed is V (m/s) and flight path angle is γ (rad). Now , for a typical glider of **your choice!** Whose shape and data should be provided:

1) Plot the equilibrium-glide values of V and γ for altitudes from 0 to 5,000 ft, assuming that the L/D is set at maximum. Let the equilibrium-glide values of V and γ be denoted by V_{Eq} and γ_{Eq} .

2) Simulate the gliding behaviour, i.e calculate and plot V, γ, h, and r versus time, using the given equations of flight using maximum L/D .
   a. Starting at 1000 ft , with initial conditions set at V_{Eq} and γ_{Eq} ,
   b. Starting at 1000 ft , with initial conditions set at V_{Eq} and $\gamma_{=0}$.
   c. Starting at 1000 ft , with initial conditions set at $V=1.5V_{Eq}$ and γ_{Eq}.
   d. Starting at 1000 ft , with initial conditions set at γ_{Eq} but increase initial velocity till the glider performs a loop.

For additional practice, you can exercise with the Napolitano's book problems!