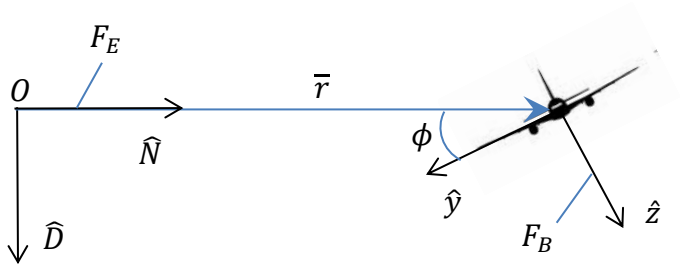
ASEN 3128 Assignment 1

Due: Thursday, Sept. 12 at 23:59, on Canvas.

A small UAV is flying in a level right turn, with a turn radius of 100m about a point *O*, and a speed relative to frame F_E of 10m/s. At a particular instant of time, the situation is as shown in the figure below.



Parts 1-8 below refer to this situation at the instant of time shown. In each case, provide a quantitative description as well as descriptive terminology for that entity. Wherever possible, also provide vector representations using the textbook's labels for the components.

1) $\bar{r}$, $\bar{r}_E$, $\bar{r}_B$
2) $\bar{V}^E = \frac{d}{dt}^E \bar{r}$, $\bar{V}_E^E$, $\bar{V}_B^E$
3) $\bar{\omega}^{EB}$, $\bar{\omega}_E^{EB}$, $\bar{\omega}_B^{EB}$
4) $\frac{d}{dt}^B \bar{r}$, $\left(\frac{d}{dt}^B \bar{r}\right)_E$, $\left(\frac{d}{dt}^B \bar{r}\right)_B$
5) $\left(\frac{d}{dt}^E \bar{V}^E\right)_E$, $\left(\frac{d}{dt}^B \bar{V}^E\right)_B$
6) Calculate $\frac{d}{dt}^E \bar{V}^E$ using the velocity rule
7) $\bar{f}$, $\bar{f}_E$, $\bar{f}_B$
8) In the above situation, suppose there is a prevailing wind with a N-component of 2 m/s, an E-component of 3 m/s, and a D-component of -1 m/s. What is the relative wind vector $\bar{V}$? What is $\bar{V}_B = \begin{bmatrix} u \\ v \\ w \end{bmatrix}$?

9) Construct a Matlab simulation of the translational dynamics of an aircraft, where the forces on the body are not a function of the body attitude, but include aerodynamic drag and gravity. Use this to model a golf ball, with mass of 30 g, diameter 3.0 cm, and coefficient of drag of 0.6.
    a. Begin the simulation with an initial position at the origin of the inertial frame, with an initial velocity components of 20 m/s upward and 20 m/s East, and assume the wind is zero. Verify that the results make sense.
    b. How sensitive is the landing location (characterized by a vertical displacement relative to the origin of zero) to horizontal (North) wind, in m of deflection per m/s of wind?
    c. If the initial velocity is constrained by a limited kinetic energy (i.e. due to human swing-strength limitations) equal to the case examined above, would longer distance be achieved by using a heavier or lighter golf ball?