

ASEN 5519 Small UAS Guidance and Control

Homework 1 Assignment

Assigned: Friday, January 20, 2023

Due: 11:59 PM, Thursday, January 26, 2023

Submit this assignment as a single pdf document through Gradescope. Include any software that is specifically requested. Do not submit code created to use your functions or generate the final answers

Problem 1

Create the following functions. Use the exact names and input structure described here. Be sure to include additional comments in the files to indicate student name, date created, and other pertinent information. You are building this code for future use! You may use any programming language you prefer, but I will provide best support for Matlab.

a. `[wind_angles] = AirRelativeVelocityVectorToWindAngles(velocity_body)`

Given the air relative velocity vector in body coordinates \mathbf{v}_B , this function returns the wind angles in the column vector $[V_a, \beta, \alpha]^T$.

b. `[velocity_body] = WindAnglesToAirRelativeVelocityVector(wind_angles)`

Calculate the aircraft air relative velocity in body coordinates from the airspeed, sideslip, and angle of attack, (the wind angles). The input and output of the function should be three-dimensional column vectors.

c. `R = RotationMatrix321(euler_angles)`

Calculate the 3-2-1 rotation matrix given the Euler angles.

d. `vector_body = TransformFromInertialToBody(vector_inertial, euler_angles)`

For a vector given in inertial coordinates, determine the components in body coordinates.

e. `vector_inertial = TransformFromBodyToInertial(vector_body, euler_angles)`

For a vector given in body coordinates, determine the components in inertial coordinates.

Problem 2

At one instant in time, an aircraft is flying such that $\phi = -3^\circ$, $\theta = 10^\circ$, and $\psi = 123^\circ$.

Further, $\mathbf{v}_B = [15, 0, 2]^T m/s$ and $\mathbf{w}_B^E = [1, 1, -1]^T m/s$.

- a. What is the angle of attack of this aircraft?
- b. Is this aircraft ascending? Justify your answer.
- c. What is the ground speed of this aircraft?

Problem 3

You are given: i.) an aircrafts inertial velocity in body coordinates, ii.) the aircrafts air relative velocity in the wind frame, and iii.) the velocity of the wind in the inertial frame. Further, you are given iv.) the rotation matrix from the wind frame to the body frame, and v.) the rotation matrix from the body frame to the inertial frame. State the correct vector or matrix notation for each term, and then write a single equation that relates them all.