

AE6520
Fall 2003
Homework #1

Due: Tuesday September 9, 2003 at 12:05pm (beginning of class)

1. Problem 1.2-5 in your textbook.

2. Show your work, illustration strongly recommended:

(a) Given $\phi = 0$, $\theta = 0$, and $\psi = \pi$, what are the elements of $C_{B/V}$ (DCM)?

(b) Given $\phi = \psi$ and $\theta = \frac{\pi}{2}$, what are the elements of $C_{B/V}$?

(c) Given $C_{B/V} = \begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$, what are ϕ , θ , and ψ ?

(d) Given $C_{B/V} = \begin{bmatrix} 0 & 0 & 1 \\ -1 & 0 & 0 \\ 0 & -1 & 0 \end{bmatrix}$, what are ϕ , θ , and ψ ?

3. Given $C_{B/V} = \begin{bmatrix} c_{xx} & c_{xy} & c_{xz} \\ c_{yx} & c_{yy} & c_{yz} \\ c_{zx} & c_{zy} & c_{zz} \end{bmatrix}$, derive a general expression for ϕ , θ , and ψ

(Hint: you can use the $\text{atan2}(\cdot, \cdot)$ function we discussed in class in the context of angle of attack to clean up your answer). Also, check your answer with the operation:

$$C_{B/V} = \begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \Rightarrow \phi = \psi = \pi, \theta = 0.$$

4. A helicopter is flying East with respect to the Earth at 100 m/s, $\phi = 0$, $\theta = 30^\circ$, and $\psi = 90^\circ$. The wind (velocity of the air with respect to the Earth) is 10 m/s along the body y-axis. What are the angle of attack and sideslip angles?

5. Problem 1.3-6 in your textbook.

6. An aircraft is flying in a head wind. The wind is along the body x-axis and the magnitude of the wind velocity relative to the Earth is 50 ft/sec. Given that the airspeed of the vehicle is 150 ft/sec, angle of attack is 10 degrees and the sideslip angle is -5 degrees

(a) Determine the ground speed of the aircraft.

(b) If the wind instantaneously disappeared (became 0 ft/sec), and meanwhile the aircraft velocity with respect to Earth was unchanged, what would the new angle of attack and sideslip angles be?