

AE6520
Fall 2002
Homework #1

Due: Friday September 6, 2002 at 11am (beginning of class)

1. Show your work, illustration recommended:

(a) Given $\phi = 0$, $\theta = 0$, and $\psi = \pi$, what are the elements of L_{BV} ?

(b) Given $\phi = \psi$ and $\theta = \frac{\pi}{2}$, what are the elements of L_{BV} ?

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

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

2. Given $L_{BV} = \begin{bmatrix} l_{xx} & l_{xy} & l_{xz} \\ l_{yx} & l_{yy} & l_{yz} \\ l_{zx} & l_{zy} & l_{zz} \end{bmatrix}$, 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:

$$L_{BV} = \begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \Rightarrow \phi = \psi = \pi, \theta = 0.$$

3. 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?

4. 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?