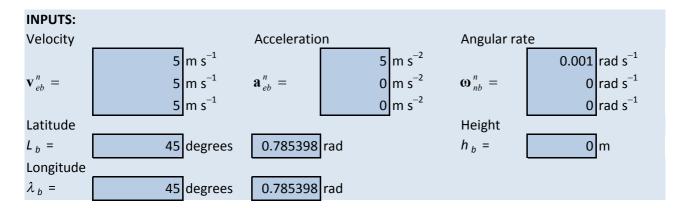
EXAMPLE 2.5(a)

Transformation of resolving axes from local navigation frame to ECEF frame



NED to ECEFcoordinate transformation matrix

From (2.150),
$$\mathbf{C}_{n}^{e} = \begin{pmatrix} -\sin L_{b} \cos \lambda_{b} & -\sin \lambda_{b} & -\cos L_{b} \cos \lambda_{b} \\ -\sin L_{b} \sin \lambda_{b} & \cos \lambda_{b} & -\cos L_{b} \sin \lambda_{b} \\ \cos L_{b} & 0 & -\sin L_{b} \end{pmatrix}$$

$$\mathbf{C}_{n}^{e} = \begin{bmatrix} -0.5 & -0.70711 & -0.5 \\ -0.5 & 0.707107 & -0.5 \\ 0.707106781 & 0 & -0.70711 \end{bmatrix}$$

Velocity transformation

From (2.152), $\mathbf{v}_{eb}^e = \mathbf{C}_n^e \mathbf{v}_{eb}^n$

$$\mathbf{v}_{eb}^{e} = \begin{bmatrix} -8.53553391 & \text{m s}^{-1} \\ -1.46446609 & \text{m s}^{-1} \\ 4.44089E-16 & \text{m s}^{-1} \end{bmatrix}$$

Acceleration transformation

From (2.152), $\mathbf{a}_{eb}^{e} = \mathbf{C}_{n}^{e} \mathbf{a}_{eb}^{n}$

$$\mathbf{a}_{eb}^{e} = \begin{bmatrix} -2.5 & \text{m s}^{-2} \\ -2.5 & \text{m s}^{-2} \\ 3.535533906 & \text{m s}^{-2} \end{bmatrix}$$

Angular rate transformation

From (2.153), $\mathbf{\omega}_{eb}^{e} = \mathbf{C}_{n}^{e} \left(\mathbf{\omega}_{nb}^{n} + \mathbf{\omega}_{en}^{n} \right)$

Transverse Radius of Curvature

From (2.106),
$$R_E(L_b) = \frac{R_0}{\sqrt{1 - e^2 \sin^2 L_b}}$$
 $R_N(L_b) = \frac{R_0 (1 - e^2)}{(1 - e^2 \sin^2 L_b)^{3/2}}$

$$R_E = 6.39E + 06$$

Meridian Radius of Curvature

$$R_N(L_b) = \frac{R_0(1-e^2)}{(1-e^2\sin^2 L_b)^{3/2}}$$

$$R_N = 6.37E+06$$

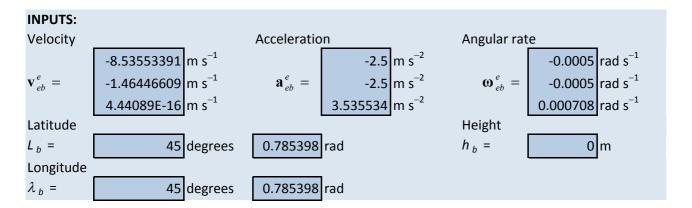
From (5.44)
$$\mathbf{\omega}_{en}^{n} = \begin{pmatrix} v_{eb,E}^{n} / (R_{E}(L_{b}) + h_{b}) \\ -v_{eb,N}^{n} / (R_{N}(L_{b}) + h_{b}) \\ -v_{eb,E}^{n} \tan L_{b} / (R_{E}(L_{b}) + h_{b}) \end{pmatrix}$$

$$\mathbf{\omega}_{en}^{n} = \begin{bmatrix} 7.83\text{E-07} & \text{rad s}^{-1} \\ -7.85\text{E-07} & \text{rad s}^{-1} \\ -7.83\text{E-07} & \text{rad s}^{-1} \end{bmatrix}$$

$$\omega_{eb}^{e} = \begin{bmatrix} -0.00049944 & \text{rad s}^{-1} \\ -0.00050056 & \text{rad s}^{-1} \\ 0.000708214 & \text{rad s}^{-1} \end{bmatrix}$$

EXAMPLE 2.5(b)

Transformation of resolving axes from ECEF frame to local navigation frame



ECEFto NED coordinate transformation matrix

From (2.150),
$$\mathbf{C}_{e}^{n} = \begin{pmatrix} -\sin L_{b} \cos \lambda_{b} & -\sin L_{b} \sin \lambda_{b} & \cos L_{b} \\ -\sin \lambda_{b} & \cos \lambda_{b} & 0 \\ -\cos L_{b} \cos \lambda_{b} & -\cos L_{b} \sin \lambda_{b} & -\sin L_{b} \end{pmatrix}$$

$$\mathbf{C}_{e}^{n} = \begin{bmatrix} -0.5 & -0.5 & 0.707107 \\ -0.70710678 & 0.707107 & 0 \\ -0.5 & -0.5 & -0.70711 \end{bmatrix}$$

Velocity transformation

From (2.152),
$$\mathbf{v}_{eb}^{n} = \mathbf{C}_{e}^{n} \mathbf{v}_{eb}^{e}$$

$$\mathbf{v}_{eb}^{n} =$$
 5 m s⁻¹
5 m s⁻¹
5 m s⁻¹

Acceleration transformation

From (2.152),
$$\mathbf{a}_{eb}^{n} = \mathbf{C}_{e}^{n} \mathbf{a}_{eb}^{e}$$

$$\mathbf{a}_{eb}^{n} = \begin{bmatrix} 5 & \text{m s}^{-2} \\ 0 & \text{m s}^{-2} \\ 0 & \text{m s}^{-2} \end{bmatrix}$$

Angular rate transformation

From (2.153),
$$\omega_{nb}^{n} = C_{e}^{n} \omega_{eb}^{e} - \omega_{en}^{n}$$

Transverse Radius of Curvature

From (2.106),
$$R_E(L_b) = \frac{R_0}{\sqrt{1 - e^2 \sin^2 L_b}}$$
 $R_N(L_b) = \frac{R_0 (1 - e^2)}{(1 - e^2 \sin^2 L_b)^{3/2}}$

$$R_E = 6.39E+06$$

Meridian Radius of Curvature

$$R_N(L_b) = \frac{R_0(1 - e^2)}{(1 - e^2 \sin^2 L_b)^{3/2}}$$

$$R_N = 6.37E+06$$

From (5.44)
$$\mathbf{\omega}_{en}^{n} = \begin{pmatrix} v_{eb,E}^{n} / (R_{E}(L_{b}) + h_{b}) \\ -v_{eb,N}^{n} / (R_{N}(L_{b}) + h_{b}) \\ -v_{eb,E}^{n} \tan L_{b} / (R_{E}(L_{b}) + h_{b}) \end{pmatrix}$$

$$\mathbf{\sigma}_{en}^{n} = \begin{bmatrix} 7.83\text{E-07} & \text{rad s}^{-1} \\ -7.85\text{E-07} & \text{rad s}^{-1} \\ -7.83\text{E-07} & \text{rad s}^{-1} \end{bmatrix}$$

$$\omega_{nb}^{n} = \begin{bmatrix} 0.001 & \text{rad s}^{-1} \\ 5.72806E-20 & \text{rad s}^{-1} \\ 2.13876E-20 & \text{rad s}^{-1} \end{bmatrix}$$