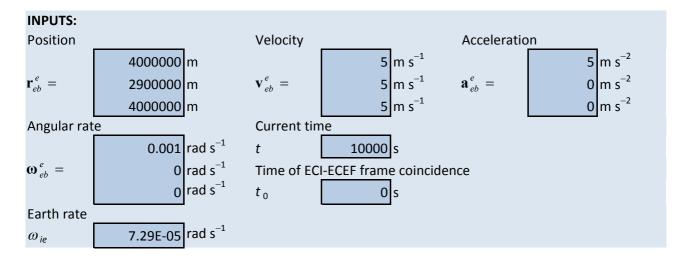
EXAMPLE 2.4(a)

Transformation of reference frame and resolving axes from ECEF frame to ECI frame



Coordinate transformation matrix

From (2.145),
$$\mathbf{C}_{e}^{i} = \begin{pmatrix} \cos \omega_{ie} (t - t_{0}) & -\sin \omega_{ie} (t - t_{0}) & 0 \\ \sin \omega_{ie} (t - t_{0}) & \cos \omega_{ie} (t - t_{0}) & 0 \\ 0 & 0 & 1 \end{pmatrix}$$
$$\mathbf{C}_{e}^{i} = \begin{pmatrix} 0.745699997 & -0.66628 & 0 \\ 0.666281858 & 0.7457 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Skew symmetric matrix of Earth rate

$$\Omega_{ie}^{e} = egin{pmatrix} 0 & -7.29 \text{E-}05 & 0 \\ 7.29 \text{E-}05 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

Position transformation

From (2.146),
$$\mathbf{r}_{ib}^{i} = \mathbf{C}_{e}^{i} \mathbf{r}_{eb}^{e}$$

$$\mathbf{r}_{ib}^{i} = \begin{bmatrix} 1050582.602 & m \\ 4827657.423 & m \\ 4000000 & m \end{bmatrix}$$

Velocity transformation

From (2.147),
$$\mathbf{v}_{ib}^{i} = \mathbf{C}_{e}^{i} \left(\mathbf{v}_{eb}^{e} + \mathbf{\Omega}_{ie}^{e} \mathbf{r}_{eb}^{e} \right)$$

$$\mathbf{v}_{ib}^{i} = \begin{bmatrix} -351.64124 & \text{m s}^{-1} \\ 83.66960078 & \text{m s}^{-1} \\ & & 5 & \text{m s}^{-1} \end{bmatrix}$$

Acceleration transformation

From (2.148),
$$\mathbf{a}_{ib}^{i} = \mathbf{C}_{e}^{i} \left(\mathbf{a}_{eb}^{e} + 2 \mathbf{\Omega}_{ie}^{e} \mathbf{v}_{eb}^{e} + \mathbf{\Omega}_{ie}^{e} \mathbf{\Omega}_{ie}^{e} \mathbf{r}_{eb}^{e} \right)$$

$$\mathbf{a}_{ib}^{i} = \begin{bmatrix} 3.721883887 & \text{m s}^{-2} \\ 3.305796161 & \text{m s}^{-2} \\ 0 & \text{m s}^{-2} \end{bmatrix}$$

Angular rate transformation

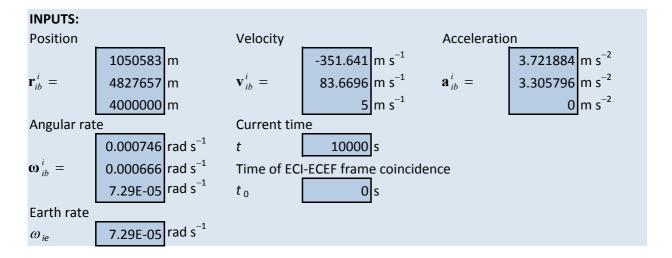
From (2.149),
$$\boldsymbol{\omega}_{ib}^{i} = \mathbf{C}_{e}^{i} \left(\boldsymbol{\omega}_{eb}^{e} + \begin{pmatrix} 0 \\ 0 \\ \omega_{ie} \end{pmatrix} \right)$$

$$\boldsymbol{\omega}_{ib}^{e} + \begin{pmatrix} 0 \\ 0 \\ \omega_{ie} \end{pmatrix} = \begin{bmatrix} 0.001 & \text{rad s}^{-1} \\ 0 & \text{rad s}^{-1} \\ 7.29E-05 & \text{rad s}^{-1} \end{bmatrix}$$

$$\boldsymbol{\omega}_{ib}^{i} = \begin{bmatrix} 0.0007457 & \text{rad s}^{-1} \\ 0.000666282 & \text{rad s}^{-1} \\ 7.29212E-05 & \text{rad s}^{-1} \end{bmatrix}$$

EXAMPLE 2.4(b)

Transformation of reference frame and resolving axes from ECI frame to ECEF frame



Coordinate transformation matrix

From (2.145),
$$\mathbf{C}_{i}^{e} = \begin{pmatrix} \cos \omega_{ie} (t - t_{0}) & \sin \omega_{ie} (t - t_{0}) & 0 \\ -\sin \omega_{ie} (t - t_{0}) & \cos \omega_{ie} (t - t_{0}) & 0 \\ 0 & 0 & 1 \end{pmatrix}$$
$$\mathbf{C}_{i}^{e} = \begin{bmatrix} 0.7457 & 0.666282 & 0 \\ -0.66628 & 0.7457 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Skew symmetric matrix of Earth rate

$$\mathbf{\Omega}_{ie}^{i} = egin{array}{cccc} 0 & -7.29 \text{E-}05 & 0 \ 7.29 \text{E-}05 & 0 & 0 \ 0 & 0 & 0 \end{array}$$

Position transformation

From (2.146),
$$\mathbf{r}_{eb}^e = \mathbf{C}_i^e \mathbf{r}_{ib}^i$$

$$\mathbf{r}_{eb}^{e} = egin{pmatrix} 4000000 & \mathsf{m} \\ 2900000 & \mathsf{m} \\ 4000000 & \mathsf{m} \end{pmatrix}$$

Velocity transformation

From (2.147),
$$\mathbf{v}_{eb}^e = \mathbf{C}_i^e \left(\mathbf{v}_{ib}^i - \mathbf{\Omega}_{ie}^i \mathbf{r}_{ib}^i \right)$$

$$\mathbf{v}_{eb}^{e} = \begin{bmatrix} 5 & \text{m s}^{-1} \\ 5 & \text{m s}^{-1} \\ 5 & \text{m s}^{-1} \end{bmatrix}$$

Acceleration transformation

From (2.148),
$$\mathbf{a}_{eb}^e = \mathbf{C}_i^e \left(\mathbf{a}_{ib}^i - 2\mathbf{\Omega}_{ie}^i \mathbf{v}_{ib}^i + \mathbf{\Omega}_{ie}^i \mathbf{\Omega}_{ie}^i \mathbf{r}_{ib}^i \right)$$

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

Angular rate transformation

From (2.149),

$$\mathbf{\omega}_{eb}^{e} = \mathbf{C}_{i}^{e} \left(\mathbf{\omega}_{ib}^{i} - \begin{pmatrix} 0 \\ 0 \\ \omega_{ie} \end{pmatrix} \right)$$

$$\mathbf{\omega}_{ib}^{i} - \begin{pmatrix} 0 \\ 0 \\ \omega_{ie} \end{pmatrix} = \begin{bmatrix} 0.000746 \\ 0.000666 \\ 0.000E+00 \end{bmatrix} \text{rad s}^{-1} \text{rad s}^{-1}$$

$$\omega_{eb}^{e} = \begin{bmatrix} 0.001 & rad s^{-1} \\ 0 & rad s^{-1} \\ 0 & rad s^{-1} \end{bmatrix}$$