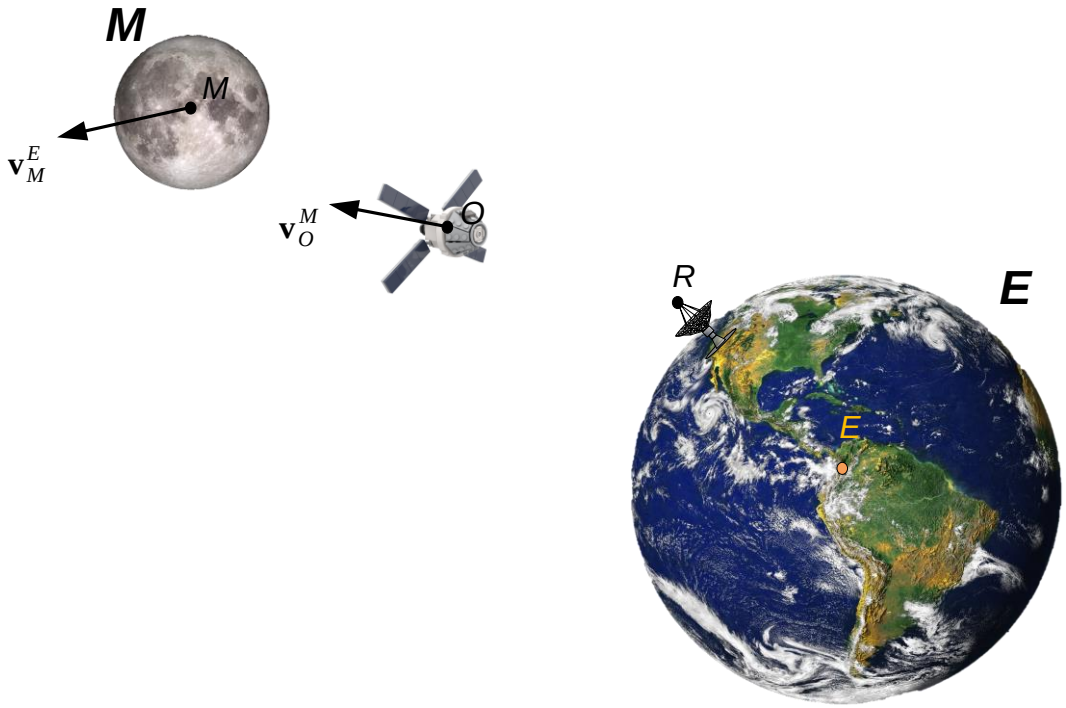
Assignments

Modeling Flight Dynamics with Tensors

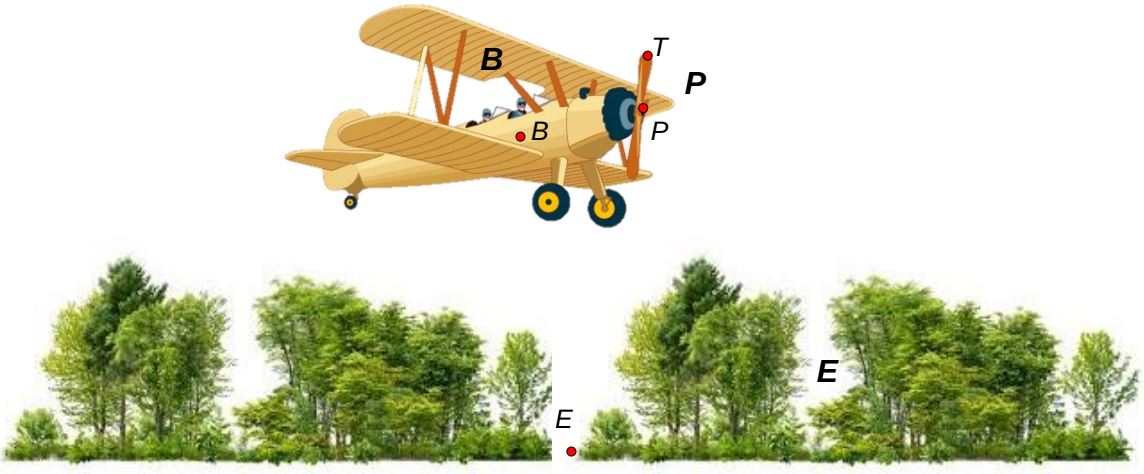
Lecture 5

Problem 1 Orion Velocity



Derive the relative velocity $\mathbf{v}_O^M$ of the Orion wrt the Moon, given the radar measured velocity $\mathbf{v}_O^R$ and the displacement vector $\mathbf{s}_{OE}$ of the Orion. Velocities and positions of Moon and Earth are given by the Celestial Almanac.

Problem 2 Propeller Tip-Speed



Calculate the speed $\mathbf{v}_T^E$ at the tip of the propeller to verify that it does not exceed sonic speed. The three frames ***E, B, P***, the four points *E*, c.m. *B, P, T*, and the three coordinate systems $]^E$, $]^B$, $]^P$ are used in the derivation.

First derive the tensor relationship for $\mathbf{v}_T^E$ given $\mathbf{v}_B^E, \boldsymbol{\omega}^{BE}, \boldsymbol{\omega}^{PB}, \mathbf{s}_{TP}, \mathbf{s}_{PB}$
Then compute the tip-speed for the aircraft making a barrel roll with speed *V*=100 *m/s*, roll rate $\dot{\phi} = 1$ *rad/sec*, pitch-up rate $\dot{\theta} = 0.1$ *rad/sec* (starting at horizontal and level) and the propeller's max angular velocity $\omega = 3000$ *RPM* . The geometrical distances are $[\overline{s_{TP}}]^P = [0 \quad 1 \quad 0]\, m; [\overline{s_{PB}}]^B = [3 \quad 0 \quad 0]\, m$. Fly the aircraft for 10 seconds.

Problem 3 Matrix Manipulation

Slide 14 uses the result $\left[\frac{dT}{dt}\right]^{BA} = [\overline{\Omega^{BA}}]^B [T]^{BA}$ without details. As an exercise you are to derive it from $[T]^{BA}\left[\overline{\frac{dT}{dt}}\right]^{BA} = [\Omega^{BA}]^B$.