AOE 4134 Homework 3
Due: Wednesday September 13, 2000 at beginning of class

Units are indicated using square brackets; *e.g.*, [km], [km/s^2].
"Discussion" questions require complete sentences.

1. The orbital period for a satellite in an elliptical orbit is $\mathsf{TP} = 2\pi\sqrt{a^3/\mu}$. Derive an expression for TP in terms of initial radius r and speed v.

2. In an inertial reference frame, an Earth-orbiting satellite has position vector

$$\vec{\mathbf{r}} = -6000\,\vec{\mathbf{I}} + 10,000\,\vec{\mathbf{J}} + 5,000\,\vec{\mathbf{K}}\ \text{[km]}$$

   and velocity vector

$$\vec{\mathbf{v}} = -5\,\vec{\mathbf{I}} + -2\,\vec{\mathbf{J}} + 1\,\vec{\mathbf{K}}\ \text{[km/s]}$$

   Note: The gravitational parameter for the Earth is $\mu = 3.986 \times 10^5\ \text{km}^3/s^2$.

   a) Determine the angular momentum vector, $\vec{\mathbf{h}}$, the eccentricity vector, $\vec{\mathbf{e}}$, the node vector, $\vec{\mathbf{n}}$, and the scalars $\mathcal{E}$, h, e, ϕ, and v_{esc}.

   b) Verify that $\vec{\mathbf{h}} \cdot \vec{\mathbf{e}} = 0$.

   c) Determine the orbital period, TP. Check that your formula for $\mathsf{TP}(r, v)$ gives the correct answer.

   d) Determine the perigee and apogee altitudes.

3. The early warning system detects a launch from a potentially hostile country. If ground tracking stations determine that at one point its flight parameters are v = 9 [km/s], r = 7500 [km], and $\phi = 25°$, determine whether this is an ICBM, an Earth satellite, or in an escape trajectory. If it is an ICBM, calculate its range over the Earth's surface; otherwise, determine the geocentric or heliocentric period.

4. Do Problem 1.17 in BMW.

5. Do Problem 2.3 in BMW.

6. Do Problem 2.5 in BMW.

Recommended, but you do not have to turn in: Do all the Problems in Chapters 1 and 2 of BMW for which partial answers are given.