MAE180 Orbital Mechanics (Spacecraft GN&C)
Assignment 2
Due 9pm, Wednesday, 30 Oct.

Note: You must show all your work in order to get credit.

Problems to hand in. (Not all problems may be graded.)

Complete list of problems.

1. (10) Let a spacecraft be in elliptical orbit around a planet with $\mu = 2 \times 10^5 \ \frac{\text{km}^3}{\text{sec}^2}$. Suppose we know the following orbital elements

$$a = 14,000.0 \text{ km}$$
$$e = 0.5$$
$$\tau = \text{2PM PST (Earth time).}$$

   What is the position of the vehicle in its orbit plane at 4:30PM PST that same day? You may assume that the first basis vector, say I^1, points toward periapsis. What is the velocity at that time? Your answers should be good to at least six significant digits.

2. (10) Write a function in matlab that, given an eccentricity, converts mean anomaly to eccentric anomaly and true anomaly. Using that function, plot the eccentric and true anomalies versus the mean anomaly for mean anomaly between $M = 0$ and $M = \pi$. The two functions, $E(M)$ and $\nu(M)$, should both be depicted in the same plot (clearly indicating which is which). Do this for both eccentricity $e = 0.1$ and $e = 0.5$.

3. (5) Suppose a vehicle is in orbit around Mars ($\mu \simeq 42828.0 \text{ km}^3/\text{sec}^2$) with semimajor axis $a = 6000$ km. Suppose it's currently at a distance of $r = 5000$ km from planet center. What is its speed? Suppose that at another time its speed was 3.2 km/sec. How far from planet center was it then?

4. (5) Suppose our vehicle is currently, i.e., at time t, at Mars, with an altitude above the planet surface of 50 km. Assume the planet is roughly spherical with a radius of 2106 km. Suppose $\vec{v}(t)$ is perpendicular to $\vec{r}(t)$. What would $v(t)$ need to be in order for our vehicle to get infinitely far from Mars without further trajectory modifications (assuming nothing untoward happens)?

5. (5) Suppose a vehicle is at Mars with specific angular momentum magnitude, $h = 2.1 \times 10^4$, and trajectory eccentricity $e = 1.5$. Suppose it's at $r = 4000$ km. What is its speed? What is its speed when it's at $r = 10^4$ km? What is its speed when it's at $r = 10^6$ km?