Astronomy 312 - Fragile
Homework 4 (assigned 2/4/16; due 2/11/16)

(6) 1. Show that the acceleration vector in cylindrical coordinates is given by

$$\frac{d^2\mathbf{r}}{dt^2} = (\ddot{R} - R\dot{\phi}^2)\hat{\mathbf{e}}_R + \frac{1}{R}\frac{\partial(R^2\dot{\phi})}{\partial t}\hat{\mathbf{e}}_\phi + \ddot{z}\hat{\mathbf{e}}_z \ . \tag{1}$$

Hint: Note that the unit vectors $\hat{\mathbf{e}}_R$ and $\hat{\mathbf{e}}_\phi$ are position-dependent and therefore time-dependent. You may find their relationships with rectangular-coordinate unit vectors helpful.

(2) 2. (a) Using the solar motion data given in Chapter 24, estimate the amplitude of the Sun's excursion in the radial direction relative to a perfectly circular orbit. Assume that the Sun is currently at the midpoint of its oscillation.

(1) (b) Does your result represent a minimum or a maximum estimate of the actual deviation?

(4) 3. (a) The mass density of stars in the solar neighborhood is approximately $0.05 M_\odot$ pc^{-3}. Assuming that the mass density is constant and that all of the stars are main-sequence M stars, estimate the fraction of the Galactic disk's volume that is occupied by stars.

(2) (b) Suppose that an intruder star (also a main-sequence M star) travels perpendcularly through the Galactic disk. What are the odds of the intruder colliding with another star during its passage through the disk? Take the thickness of the disk to be 1 kpc.