Physics 3345 **Professor Scalise**
Fall 2000 **Assignment #7**

Due: Monday 23 October 2000

1. Show that the bead in example 7.7 of Marion & Thornton will remain in equilibrium at any constant radius R (and hence any height z).

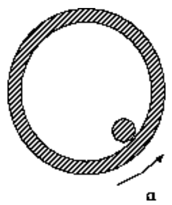
   (a) Draw the free-body diagram for the bead in the rotating frame (where there are fictitious forces).

   (b) From the free-body diagram alone, find the angle that the normal force makes with the vertical.

   (c) Use the formula for the parabola $z = cr^2$ with $c = \frac{\omega^2}{2g}$ to find the slope of the tangent line at the position of the bead. This is also the angle that the normal force makes with the vertical. Show that the answer is identical to part (b).

   (d) To see why this is amazing, work through example 7.7 with a cubic curve $z = c'r^3$ instead of a parabola and solve for c'. Comment.

2. [This problem will take more than 10 minutes. Don't wait until the day before the homework is due to begin!] A cylinder of mass m and radius r rolls inside a hollow cylinder with inner radius R as shown in the figure. The exterior cylinder has constant angular acceleration α. Using indeterminate multipliers, figure out at which angle will the inner cylinder will stabilize (roll in place).



3. Marion & Thornton 7-4. To answer the last question, take the time derivative of $(T + U)$ and see if it vanishes.

4. A particle of mass m moves in one dimension under the influence of a time dependent force

$$F(x,t) = \frac{k}{x^2} e^{\frac{-t}{\tau}}$$

where k and τ are positive constants. Compute the Hamiltonian and the energy. Are they identical? Is either conserved?