PHY 3221 : Intermediate Mechanics, Spring 2002

January 18^{th}, 2002
Assignment # 2
(due Friday January 25^{th}, 2002, at the beginning of class)

1. Find the velocity $v(t) = \dot{x}(t)$ and the position $x(t)$ as functions of the time t for a particle of mass m, which starts at rest at $x=0$ and $t=0$, subject to the following force functions:

(a) $F_x = F_0 + c\,t$

(b) $F_x = F_0 \sin(c\,t)$

(c) $F_x = F_0\, e^{ct}$

You can learn about how to integrate a differential equation using *Maple* from *Tutorial n. 2*. This is a good problem to try your solutions by hand and check them with *Maple* (Try them by hand first, you will not have *Maple* during your tests)!

2. Read *Tutorial n. 2* and understand how to use *Maple* to solve a system of equations, looking in particular at the simple example of a block sliding on an incline. We have discussed this in class, so you should be able to follow your notes and compare with the commands and the explanations in *Tutorial n. 2*.

Now, look at the example described in Section 2.3.1 of Greene's book (see attached copies). You should be able to understand the force diagrams and how 2^{nd} Newton's law is applied to derive the equations of motion for the two blocks. When you can see how the solution goes, try to implement it in *Maple* , following Greene's method and answer the following question:

– if the coefficient of kinetic friction is $\mu_k = 0.3$, $m_1 = 2m$ and $m_2 = m$, what angle θ of the incline allows the masses to move at a constant speed?

3. Problem 2.3 of Marion and Thornton's book.

4. Problem 2.6 of Marion and Thornton's book.

5. Problem 2.8 of Marion and Thornton's book.

6. **For graduates** (bonus for undergraduates)
Consider the motion of a projectile in $D = 3$ dimensions, i.e. the one described by the equation of motion:

$$m\,\frac{d^2\mathbf{r}(t)}{dt^2} = -m\,g\,\hat{\mathbf{k}}$$

where $\mathbf{r}(t) = x(t)\,\hat{\mathbf{i}} + y(t)\,\hat{\mathbf{j}} + z(t)\,\hat{\mathbf{k}}$ and $(\hat{\mathbf{i}}, \hat{\mathbf{j}}, \hat{\mathbf{k}})$ are the unit vectors of the three cartesian axes. Show that it reduces to a motion in D=2 dimensions, i.e. in a plane defined by the z-axis and by the line of equation $y = b\,x$ where $b = v_{0_y}/v_{0_x}$.