Physics 321 – Spring 2004

Homework #7, due at beginning of class Wednesday Mar 17.

1. [9 pts] A "triangle wave" can be defined by $F(t) = 1 - 2\omega|t|/\pi$ for $-\pi/\omega < t < +\pi/\omega$, with $F(t)$ defined at all other values of the time t by the property of having period $2\pi/\omega$.

   (a) Find the Fourier series representation of the $F(t)$. Express your answer BOTH in exponential form and in the form of sines and/or cosines.

   (b) Solve the driven damped oscillator equation $\ddot{x} + 2\beta\dot{x} + x = F(t)$ in the form of an infinite series. You will probably find the exponential form of your answer to part (a) more convenient.

   (c) Plot the solution $x(t)$ over a time interval of two periods: $0 < t < 4\pi/\omega$ for the case $\beta = 0.1$, with $\omega = 1/3,\ 1/2,\ 1,\ 2$. (Make four separate plots—one for each choice of ω.)

2. [4 pts] Marion & Thornton, problem 4-1. Note that the rest length of the springs is $\ell - d$, not just ℓ. You will need the Taylor series expansion of $(1+y)^{-1/2}$ were $y = (x/\ell)^2$.

3. [4 pts] Marion & Thornton, problem 4-3. Draw the phase space diagram ($\dot{x}$ vs. x) right below the potential energy plot, as is done in Figure 4-5 in the book, so it is easy to see the correspondence between the two diagrams.

4. [4 pts] Marion & Thornton, problem 4-6. Use conservation of energy to calculate $\dot{\theta}$ as a function of θ.

5. [4 pts] Marion & Thornton, problem 4-8.

(Last updated 3/05/2004.)