Physics 22 Problem Set 6

Harry Nelson

Due Monday, May 14 in class

For the rest of week we study the 3 times of damped oscillators: underdamped, critically damped, and overdamped. Pertinent sections of the book are 10.2 (pp. 414-421) and note 10.1 (pp. 433-437).

The instructor is Harry Nelson, the TA is Joel Varley. A web page for the course is set up at http://hep.ucsb.edu/courses/ph22.

We meet MWF 1:00-1:50pm in 1640 Broida. There are **two sections**, attendance at **both** is mandatory. Joel Varley's section will take place Friday 11:00-11:50pm in 1802 Psychology, and Harry Nelson's will take place Friday 2:00-2:50pm in 2129 Girvetz. Harry Nelson's office hours will follow section until 5:00pm on Friday, either in 2129 Girvetz (if possible) or in the PSC. Joel Varley's office hours will will take place in the Physics Study Room (1019 Broida) on Tuesday from 9:00am to 10:00am, Thursday from 9:00am to 10:00am, and Friday noon-1:00pm.

Please make your work neat, clear, and easy to follow. It is hard to grade sloppy work accurately. Generally, make a clear diagram, and label quantities. Derive symbolic answers, and then plug in numbers after a symbolic answer is available.

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1. A mass $m = 0.1\,\mathrm{kg}$ is attached to a spring of spring constant $k = 0.4\,\mathrm{N/m}$, and the amount of friction (a.k.a. damping) is described by a constant b that can be varied. Newton's law for the mass is:

   $$m\ddot{x} = -kx - b\dot{x}$$

   The mass at $t = 0$ is at $x = 0$, but does have a velocity $v_0 = 0.2\,\mathrm{m/s}$. For each of the following choices of b, evaluate the time constant(s) that describe the system numerically, and comment as to whether the system is underdamped, overdamped, or critically damped. Then use the initial values for x and v to synthesize the actual equations that describe the motion of the mass for times from $t = 0$ to $t = 40\,\mathrm{s}$. Plot all three motions on the same $t - x$ axis.

   (a) $b = 5 \times 10^{-3}\,\mathrm{kg/s}$.

   (b) $b = 0.4\,\mathrm{kg/s}$.

   (c) $b = 0.2\sqrt{20} = 0.894\,\mathrm{kg/s}$.
