MATH 304, ODE, Fall 2006

Lab Project #2

Active Shock Absorbers

DUE DATE: Monday, Oct. 30th, in class.

The goal of the project is for you to investigate a modified harmonic oscillator equation with the damping constant b replaced by a function of the velocity $b(v)$. This is intended to model an active shock absorber system for truck and school bus seats. (Recall the good old days: Riding in the back of the bus was a great way to get a really exciting ride!) The goal is to pick a good oscillator that gives both a smooth ride and handles big bumps.

It is **required** that you work in a group of two or three people. Any help you receive from a source other than your lab partner(s) should be acknowledged in your report. For example, a textbook, web site, another student, etc. should all be appropriately referenced at the end of your report. The project should be typed although you do not have to typeset your mathematical notation. For example, you can leave space for a graph, computations, tables, etc. and then write it in by hand later. You can also include graphs or computations in an appendix at the end of your report. Your presentation is important and I should be able to clearly read and understand what you are saying. Only **one project per group** need be submitted.

Your assignment is to **complete Lab 2.5** on pp. 231 - 232 of the course text. As you answer all of the questions listed, be sure to keep the following in mind:

- Before starting any numerical work, consider each of the three sample damping expressions:

$$b_1(v) = v^4 \quad (1)$$
$$b_2(v) = 1 - e^{-10v^2} \quad (2)$$
$$b_3(v) = \arctan v. \quad (3)$$

  What do they have in common and where are they different? You should especially consider the physics of the problem. Sketch a graph of all three on the same plot (feel free to use Maple or a graphing calculator to do this.)

- Your ultimate goal is to describe the behavior of $y(t)$ for each $b_i(v)$ and for different initial conditions. Be as specific as possible in your answers. You should include graphs of the yv-plane (phase portrait) as well as component graphs of y versus t. But keep the goal in mind. The interpretation of what these pictures reveal is the key. Don't overload your report with large numbers of graphs that all tell the same story.

- You will need to convert the 2nd-order oscillator equation into a 1d-system so that you can use the DE Tool HPGSystemSolver. You may also use Polking's program PPlane available from the course webpage (use `atan` to get the function arctan.)

- When answering question **4.** on the lab, use your conclusions from the first item above (the comparison of the b_i's) to help justify your answer.