

MATH 442: Mathematical Modeling

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Homework assignment 6 – due 11/4/2010

Problem 1 (Group project de-briefing). Explain in a few sentences how well your group worked together and rate the contributions of each member of your group (including your own) on a scale from 1 (hardly contributed at all) to 10 (definitely carried his/her weight). If you have thoughts on this particular project's technical side, or how well it was suited to being worked on in groups, please share that as well – remember that as teachers we are still continuously learning how to do things better and need this sort of feedback. **(2 points)**

Problem 2 (Rollin' around). In class we have derived the equations for a marble rolling around on a surface described by the function $f(\mathbf{x}) = f(x, y)$. Let's assume that gravity is $g = 1 \frac{m}{s^2}$. Implement a program in Maple that (i) plots the function $f(\mathbf{x})$ with sufficient resolution to show how it looks, (ii) numerically solves the equations of motion of the marble, (iii) plots its trajectory in an $x(t)$ — $y(t)$ plot for the time interval $0 \leq t \leq 500$ (make sure it shows the same range for the x - and y -values, and that the number of points in the curve is large enough to show it as a smooth curve). Interpret the trajectory, i.e. discuss why it looks this way by comparing it with the function $f(\mathbf{x})$.

Part a (smooth operator): Do the steps above for $f(\mathbf{x}) = |\mathbf{x}|^2 + \sin(x_1) + \cos(x_2)$ and with initial conditions $\mathbf{x}(0) = (20, 18)^T$, $\dot{\mathbf{x}}(0) = (0, 0)^T$. **(8 points)**

Part b (drunken sailor): Repeat the same steps for the function $f(\mathbf{x}) = \frac{1}{400}|\mathbf{x}|^2 + \sin(x_1) + \cos(x_2)$ and the same initial conditions. **(4 points)**

Part c (pinball): Repeat the same steps for the function $f(\mathbf{x}) = \frac{1}{1000}|\mathbf{x}|^2 + \arctan \left[100 (\sin(x_1) + \cos(x_2)) - \frac{3}{4} \right]$ and the same initial conditions. Plot for the time interval $0 \leq t \leq 5000$. Can you still make the curve look smooth by asking Maple to plot more points? If not, interpret why not. **(6 points)**

I try to be as good a teacher as possible, but to succeed in this goal I need feedback from those who see me teach, i.e. you. If you have comments on the way I teach – in particular suggestions how I can do things better, if I should do more or less examples, group work vs. whiteboard, etc – or on other things you would like to critique, feel free to hand those in with your homework as well. I want to make this as good a class as possible, and all comments are certainly much appreciated!