MATH 131, Sections 02 and 04, Fall 2005

Calculus Lab #4

Optimization and Firebreaks

DUE DATE: Friday, November 18th, Start of class

The goal for this project is to apply the theory of optimization of a function of one variable to a fire management technique called *firebreaks*. Most of the problems can be done using pen and paper, although you will need Maple or a calculator for some of the computations. 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. Please turn in one report per group, listing the names of the groups members at the top of your report.

Your lab should consist of coherent and sufficiently detailed answers to the questions below. Be sure to answer all questions carefully and neatly, writing in complete sentences. As always, SHOW YOUR WORK. You do **NOT** need to type up your answers for this lab.

1. A Warm-up Problem

Find the point on the parabola $y = x^2$ which is closest to the point $(1, 0)$. Give the coordinates of this point to six decimal places and be sure to show it is an actual minimum.

Hint 1: Minimize the **square** of the distance between a point (x, y) on the parabola and the point $(1, 0)$. This avoids square roots. If the square of the distance has a minimum value at $x = c$, then so does the actual distance itself. This is due to the fact that the square root function is an increasing function.

Hint 2: To find the solution with enough accuracy you will need to find the roots of a certain polynomial using Maple or a calculator. In Maple, the important command to use is `fsolve` . For example, to find the roots of the polynomial $x^4 - 3x^3 + 2x - 13$, type

```
fsolve(x^4 - 3*x^3 + 2*x - 13 = 0,x);
```

This should output the two real roots -1.525052357 and 3.201133117.

2. Firebreaks

Do the following optimization problem on firebreaks, a technique used by fire management officials to minimize the damage done by forest fires. This is Project #4 in the text at the end of Chapter 4, pp. 237-238.

Hint: Let x denote the number of firebreaks. This means that x is technically an integer (you can't have 2.3 firebreaks). However, you should treat x as a real variable just as usual. Finding the x-value which minimizes the area lost to fire will then help you locate the actual *integer* value of x which minimizes the area lost to fire. Be sure that your final answer is an integer. Part **(b)** is a little harder. You will need to use Maple or a calculator to find the minimum in this case. See the syntax above for the command `fsolve`.