ME 748: Optimum Design of Mechanical Elements and Systems
Spring 2007; Assignment-2

Due: 12th Feb 2007; 5 pm in ECB 3108

Problem 1: Prove the following: Suppose a function $f(x)$ is infinitely differentiable and

$$\frac{d^n f(x^*)}{dx^n} = 0 \text{ for } n = 1,2,3,...,2m-1$$

$$\frac{d^{2m} f(x^*)}{dx^{2m}} > 0$$

then x^* is a local minimum.

Problem 2: Use the above Lemma to decide whether 0 is a local minima for $f(x) = x^n$ for $n = 1,2,3,\ldots$.

Problem 3: Find and classify the stationary points for: (a) $f(x) = x^3 + 6x^2 - 15x + 2$, (b) $f(x) = x^2 e^x$, (c) $f(x) = x + x^{-1}$

Problem 4: Suppose $f(x_1) = f_1; f(x_2) = f_2; f(x_3) = f_3$, where $x_1 < x_2 < x_3$, and $f_1 > f_2 < f_3$. Find an estimate for the local minimum x^* via parabolic interpolation. Your expression should involve the three points and the three function values.

Problem 5: Write a Matlab function to that exploits the above result to recursively find the minima of functions. The Matlab code should be of the form:

```
function [xmin, fmin,nIterations] =
minimizeViaParabolicInterpolate_LastName(f, a0, b0, xtol)
```

where the function parameters are identical to the goldenSection.m code made available to you. Test and compare your code against goldenSection for accuracy and efficiency. Observe that only an xtol is provided for termination. Submit your results along with the rest of your solution, and email me your code. Did you encounter any pathological conditions under which your code failed?

Problem 6: Pick any of the five MATLAB optimization toolbox functions discussed in class. Determine (via online resources, etc) the algorithm used by this function, and provide couple of examples to illustrate the behavior of the algorithm.

Problem 7: Suppose $G(x) = x^2 - 4\sin(x)$. Starting at $x_0 = 3$, use Newton's method to find the next two iterations x_1 & x_2