AMSC/CMSC 660 Quiz 9 , Fall 2010

Show all work. You may leave arithmetic expressions in any form that a calculator could evaluate. By putting your name on this paper, you agree to abide by the university's code of academic integrity in completing the quiz. Use no books, calculators, cellphones, other electronic devices, communication with others, scratchpaper, etc.

Name _____

1. (10) Jeremy has taken 8 quizzes in this course and has recorded for each quiz his grade g_i and also h_i, the number of hours that he studied. He has never gotten a perfect score. How can he estimate how many hours he needs to study for quiz 9 in order to get a perfect score (20 points)?

(10 points for a correct answer involving inverse interpolation; max of 8 points for other reasonable answers.)

2. (10) An auto engineer wants to design a car bumper to withstand a 2 mph impact without damage.

- There are 10 design parameters x_i, $i = 1, \ldots, 10$ that she can vary to change the shape of the bumper and its material composition.
- She has 10 crash situations, corresponding to impact at different positions on the bumper.
- If the bumper is displaced by less than $\epsilon = .01$ inch, then there is "no damage".
- To see what happens in crash situation j ($j = 1, \ldots, 10$), she solves a partial differential equation, discretized to a system of 1,000,000 equations in 1,000,000 unknowns, and computes $d_j(\boldsymbol{x})$ = the maximum displacement of any part of the bumper by the crash.
- No other information, such as derivative values, are returned by the software that produces the value $d_j(\boldsymbol{x})$.
- The engineer wants to determine good design parameters $\boldsymbol{x}$ by solving the nonlinear system of equations

$$F_j(\boldsymbol{x}) = \max(d_j(\boldsymbol{x}) - \epsilon, 0), \quad j = 1, \ldots, 10.$$

Advise the engineer on what algorithm should be used to solve $\boldsymbol{F}(\boldsymbol{x}) = \boldsymbol{0}$ and what difficulties might be encountered.