



24.767 OPTIMIZATION METHODS FOR COMPUTER-AIDED DESIGN

ASSIGNMENT 5

Due Date: March 31, 2005

Instructor: J. LoVetri

General Instructions: This assignment is to be written up neatly since messy work will not be marked. All programs which are written for the assignment are to be fully commented and included in an Appendix at the end of the assignment. Relevant program output used to answer a question is to be transferred into tables which should be included in the main body of the report at the location where each table is being referred to.

- 1) A thermal station contains three units which consume fuel at the following rates in [gigajoules/hr] (with electrical power P_i in [MW]):

(A) 250 [MW] Unit: $F_a = 350 + 8.3P_a + 0.0024P_a^2$

(B) 350 [MW] Unit: $F_b = 400 + 8.2P_b + 0.0020P_b^2$

(C) 300 [MW] Unit: $F_c = 430 + 8.2P_c + 0.0017P_c^2$

The total losses are given by $L(P) = 0.1P_a + 0.1P_b + 0.2P_c$ and the *efficiency ratio*, η , is defined as the ratio of power supplied to all the loads, P_L , to the total fuel per hour consumption, $F_T = F_a + F_b + F_c$.

- (i) If the total power to be supplied to all loads, P_L , is 500 [MW], what is the power supplied by each unit which minimizes the **total** fuel consumption? Use the Lagrange multiplier method and explain the steps in the solution.
What is the optimal total fuel consumption in [gigajoules/hr]?
- (ii) If the total load, P_L , is slightly increased will the efficiency ratio increase or decrease? Justify your answer?
- (iii) At what total load is the least energy per hour consumed? Does this correspond to the best efficiency ratio (*i.e.*, greatest efficiency ratio)?
- (iv) If unit C is shut down **totally**, *i.e.*, $F_c = 0$, what is the new loading on units A and B for minimum fuel consumption? What is the change in the **total fuel consumption** because of the shutdown of unit C? From an economic standpoint, should you keep unit C running?

- 2) Do Problem 19.13 in the textbook.
- 3) Consider the following constrained minimization problem:

$$\begin{aligned} \text{Minimize } f(\mathbf{x}) &= \frac{1}{3}(x_1 + 1)^3 + x_2 \\ \text{Subject to: } g_1(\mathbf{x}) &= -x_1 + 1 \leq 0 \\ g_2(\mathbf{x}) &= -x_2 \leq 0 \end{aligned}$$

- (a) Formulate the problem using an interior penalty method.
 - (b) Solve the problem, by computer, using any method you wish. Explain your method and discuss the results
- 4) Do Problem 12.14 in the textbook.
 - 5) Do Problem 12.16 in the textbook.
 - 6) Do Problem 12.25 in the textbook.

