University of Saskatchewan
Department of Electrical Engineering
EE 442.3 Power System Operation & Control (Term 2)
Mid-Term Examination (Total Duration: 2 hrs)

Dated: 2006-02-06 **Time: 5:30 pm – 7:30 pm**
Instructor: Dr. Rama Gokaraju **Total Marks: 30**

Instructions:

1) The examination paper consists of 4 problems and 2 pages in total.
2) This is a closed-book examination. One-page formula sheet is allowed. The formula sheet should not include solved problems.
3) Your solutions should be methodical (write the steps of numerical computations clearly).
4) You are advised to attempt Problem 1 at the end.
5) Marks allotted for each problem is shown on the right margin.

Problem 1

Power system engineer often relies on rules of calculus to maximize or minimize a function of several variables. Lagrange multiplier method is one such technique to find the maximum or minimum of any objective function.

Use the Lagrange multiplier method to determine the minimum distance from origin of the xy plane to a circle described by

$$(x-8)^2+(y-6)^2=25$$

Note: You have to obtain the solution through Lagrange optimization method only.

7.5 Marks

Problem 2

The fuel-cost functions for three thermal plants in *$/h* are given by

$$F_1(P_1)=500+5.3P_1+0.004P_1^2$$
$$F_2(P_2)=400+5.5P_2+0.006P_2^2$$
$$F_3(P_3)=200+5.8P_3+0.009P_3^2$$

where P_1, P_2 and P_3 are in *MW*. The total load is 975 *MW*. The generator limits are as follows:

$200MW < P_1 < 450MW$

$150MW < P_2 < 350MW$

$100MW < P_3 < 225MW$

Neglecting line losses, find the optimal dispatch and the total cost in *$/h* by the method of *Lagrange constrained optimization method.*

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7.5 Marks

Problem 3

Assume that all three of the thermal units described below are running. Find the economic dispatch schedules using the lambda-iteration for a total demand of 450 MW. Assume the initial value of lambda as given below:

150MW

$\lambda_{initial} = 8.0\$/MWh$

Unit Data (MBtu/h)	Minimum (MW)	Maximum (MW)	Fuel Cost ($/MBtu)
$H_1 = 225 + 8.4P_1 + 0.0025P_1^2$	45	350	0.80
$H_2 = 729 + 6.3P_2 + 0.0081P_2^2$	45	350	1.02
$H_3 = 400 + 7.5P_3 + 0.0025P_3^2$	47.5	450	0.90

7.5 Marks

Problem 4

We are given an isolated power system with the following data (all quantities refer to a 1000 MVA base),

$M_1 = 3.5pu$ $D_1 = 1.00$

$M_2 = 4.0pu$ $D_2 = 1.20$

Calculate the final frequency for load-step change of 0.2 *pu* (i.e. 200 MW). Assume that the frequency was at the nominal value (60 Hz) initially.

7.5 Marks

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