Economic Dispatch

Exercise 1

The cost functions ($/h) for two 800 MW thermal units are given by:

$$C_1 = 400 + 6P_1 + 0.004P_1^2 \quad \text{and} \quad C_2 = 500 + \beta P_2 + \gamma P_2^2$$

where P_1 and P_2 are in MW.

1) The incremental cost of power is $\lambda = 8\ \$/MWh$ when the total power demand is equal to $P_D = 550MW$. Neglecting losses, determine the optimal generation of each unit.

2) Repeat question 1) if $\lambda = 10\ \$/MWh$ when $P_D = 1300MW$.

3) From the answers to 1) and 2), find the coefficients β and γ.

Exercise 2

The cost functions ($/h) for two thermal units are given by:

$$C_1 = 120.312 + 2.187P_1 + 0.016P_1^2 \qquad 200 \leq P_1 \leq 380$$

$$C_2 = 74.074 + 2.407P_2 + 0.019P_2^2 \qquad 100 \leq P_2 \leq 200$$

where P_1 and P_2 are in MW.

1) For a total generation of $P_T = P_D + P_L = 400\ MW$, determine the generation sharing between the two units.

2) Calculate the total production cost. Give the meaning of the incremental cost.

3) Determine the generation sharing between the two units for $P_T = 550\ MW$.

Exercise 3

The cost functions for three thermal units of an electric power system in $/h are given by:

$$C_1 = 350 + 7.20P_1 + 0.0040P_1^2$$
$$C_2 = 500 + 7.30P_2 + 0.0025P_2^2$$
$$C_3 = 600 + 6.74P_3 + 0.0025P_3^2$$

where P_1 , P_2 and P_3 are in MW

1) If $P_1 = P_2 = P_3$ for a total demanded power of $P_D = 450MW$, calculate the total production cost.

2) For this same demanded power, determine the optimal generation sharing among the three units. Then calculate the total production cost and the cost saving achieved.

3) If the generation limits of these units are as follows:

$$122 \leq P_1 \leq 400 \qquad 260 \leq P_2 \leq 600 \qquad 50 \leq P_3 \leq 445$$

For a total power demand of 450 MW and neglecting losses, calculate in this case the optimal generation of each unit. Deduce the total production cost.

4) Repeat question 3) for a total demanded power of $P_D = 1335MW$.

Exercise 4

Consider a system with two generators supplying a given load. P_1 and P_2 denote the powers supplied by generators 1 and 2, and P_D the total load power.

1) Using the Lagrange formulation, give the condition for the solution of the economic load dispatch problem that minimizes the total generation cost F while taking losses into account P_L.

2) For a load demand of $P_D = 40MW$, P_1 and P_2 the incremental costs of the two generators are:

$$IC_1 = \frac{dF_1}{dP_1} = 10000\ DA/MWh \quad \text{and} \quad IC_2 = \frac{dF_2}{dP_2} = 12500\ DA/MWh$$

The line losses are

$$P_{L(pu)} = 0{,}5P_{1(pu)}^2$$

where the loss coefficient is given in p.u. on the 100 MVA base.

Find the values of P_1 and P_2 and the value of the losses P_L.

Exercise 5

The cost functions for 2 thermal units of an electric power system in kDA/h are given by:

$$C_1 = 320 + 6.2P_1 + 0.004P_1^2 \quad \text{and} \quad C_2 = 200 + 6.0P_2 + 0.003P_2^2$$

where P_1 and P_2 in MW are limited as follows:

$$50 \leq P_1 \leq 250 \qquad 50 \leq P_2 \leq 350$$

The power losses in the system are given in p.u. on the base $S_b = 100MVA$ by the following expression:

$$P_L = 0.0125P_1^2 + 0.0625P_2^2$$

For a demand of $P_D = 412.35MW$ and taking an initial value for the incremental cost $\lambda = 7$ kDA/MWh, calculate the optimal generation of each unit.