ECEN 460 SPRING 2024 (Birchfield) Quiz 15 2 Apr 2024

Name: ____________________ UIN: _________ Section: ______ Score: ________

A system has three generators with the following cost curves.

$$C_1(P_1) = 8600 + 13\ P_1 + 0.002\ P_1^2$$
$$C_2(P_2) = 3400 + 10\ P_2 + 0.005\ P_2^2$$
$$C_3(P_3) = 1700 + 4\ P_3 + 0.012\ P_3^2$$

C_1, C_2, and C_3 are the generator costs, in \$/hr
P_1, P_2, and P_3 are the generator real power outputs, in MW
Each generator must be dispatched within the following limits

$$25\text{ MW} \le P_1 \le 450\text{ MW}$$
$$15\text{ MW} \le P_2 \le 500\text{ MW}$$
$$35\text{ MW} \le P_3 \le 425\text{ MW}$$

If the total system load is 700 MW, what should be P_1, P_2, and P_3 to minimize the total system cost $C_1 + C_2 + C_3$? Also give the system marginal cost λ. (Remember that for generators not at a limit, the incremental cost (dC/dP) should be equal to λ.) You may use either the direct method or lambda iteration method. If you use the lambda iteration method, start with $\lambda_H = 20$ and $\lambda_L = 10$ and complete 6 iterations.

Direct Method

$$\lambda = 13 + 0.004P_1 = 10 + 0.01P_2 = 4 + 0.024P_3$$
$$P_1 + P_2 + P_3 = 700$$

Solving these equations results in $P_1 = 15, P_2 = 306, P_3 = 378$. Since this results in a limit violation for P_1, set $P_1 = 25$ and resolve

$$\lambda = 10 + 0.01P_2 = 4 + 0.024P_3$$
$$25 + P_2 + P_3 = 700$$

Which results in $P_1 = 25\ MW, P_2 = 300\ MW, P_3 = 375\ MW, \lambda = 13\ \$/MWh$

Lambda iteration method
Solve for powers as a function of lambda, subject to limits

$$P_1 = (\lambda - 13)/0.004$$
$$P_2 = (\lambda - 10)/0.01$$
$$P_3 = (\lambda - 4)/0.024$$

λ_H	λ_L	λ_M	P_1	P_2	P_3	P_{total}
20	10	15	450	500	425	1375
15	10	12.5	25	250	354.2	629.2
15	12.5	13.75	187.5	375	406.3	968.8
13.75	12.5	13.125	31.25	312.5	380.2	724.0
13.125	12.5	12.813	25	281.25	367.2	673.4
13.125	12.813	12.97	25	296.9	373.7	695.6