23

B.Sc. in EEE, 8th Semester

Date: February 20, 2023
Time: 2:00 PM – 3:30 PM

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 4835
Course Title: Power System Operation and Control

Summer Semester, A. Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

There are 3 **(three)** questions. Answer all 3 **(three)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

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1. a) Define incremental cost and heat rate of thermal generating unit. **05 (CO1, PO1)**

   b) Explain with example why the lambda-iteration technique is a more generalized approach for solving the economic load dispatch problem compared to the Lagrange multiplier approach. **07 (CO1, PO1)**

   c) Consider a three-generator system with the following quadratic cost functions **13 (CO2, PO2)**

$$C_1(P_{G1}) = 900 + 10P_{G1} + 0.05P_{G1}^2 \ \$/hr$$
$$C_2(P_{G2}) = 500 + 18P_{G2} + 0.04P_{G2}^2 \ \$/hr$$
$$C_3(P_{G3}) = 800 + 15P_{G3} + 0.01P_{G3}^2 \ \$/hr$$

   Given the load demand as 1000 MW, and ignoring generation limits and transmission losses, find out the optimal generation outputs using lambda-iteration method. Assume, $\lambda^H = 30$, and choose sufficiently small value of tolerance (ε) for convergence.

2. a) The Lagrangian function of a three-generator power system is given as **03+03+04 (CO2, PO2)**

$$L = 700 + 4.3P_{G1} + 0.005P_{G1}^2 + 400 + 5.1P_{G2} + 0.004P_{G2}^2 + 800 + 6.0P_{G3} + 0.008P_{G3}^2 + \lambda(850 - P_{G1} - P_{G2} - P_{G3}) + \mu_1(P_{G1} - 400) + \mu_2(150 - P_{G1}) + \mu_3(P_{G2} - 300) + \mu_4(100 - P_{G2}) + \mu_5(P_{G3} - 500) + \mu_6(130 - P_{G3})$$

   i) List the cost functions of the generating units.
   ii) Identify the equality and inequality constraints.
   iii) In a trial with all $\mu_i = 0$, the optimum solution is obtained as $P_{G1} =$ 368 MW, $P_{G2} =$ 360 MW and $P_{G3} =$ 122 MW. Justify the feasibility of the solution with proper reasoning.

   b) The data of a four generating unit system is given as follows **10 (CO2, PO2)**

Unit No.	$P_{g,max}$ (MW)	$P_{g,min}$ (MW)	Heat Rate (MBTU/h)	Fuel Cost ($/MBTU)
1	250	50	$510 + 7.1P_{G1} + 0.00142P_{G1}^2$	1.20
2	300	80	$310 + 7.8P_{G2} + 0.00198P_{G2}^2$	1.05
3	500	150	$150 + 6.9P_{G3} + 0.00115P_{G3}^2$	1.11
4	420	100	$480 + 5.5P_{G4} + 0.00129P_{G4}^2$	1.00

Construct a priority list for shutting down the units based on the full-load average production cost.

c) Discuss why the unit commitment problem is classified as a mixed-integer programming problem. **05 (CO1, PO1)**

3. a) Define spinning reserve and off-line reserve of a thermal power system. **05 (CO1, PO1)**

b) Explain with examples the minimum up time and minimum down time constraints associated with a thermal power plant operation. **05 (CO1, PO1)**

c) Consider a two-area power system as shown in figure 3(c). The maximum power transfer capacity of the interconnectors is given as 440 MW. **15 (CO2, PO2)**

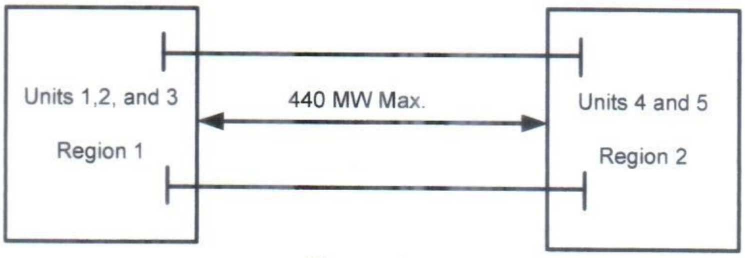

Figure 3(c)

The units are currently supplying a total demand of 3000 MW as per the following table

Units	Unit Capacity (MW)	Unit Output (MW)	Regional Load (MW)	Interchange (MW)
1	1100	900	1600	250 Out
2	850	500		
3	900	450		
4	1000	750	1400	250 In
5	500	400		

i) Calculate the spinning reserve for the above-mentioned case.

ii) Analyse whether the outage of Unit 3 would overload the interconnector or not.