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M.Sc. Engg./ Ph.D. (EE) Date: February 15, 2023 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 6311
Course Title: Power System Optimization

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

There are 4 **(four)** questions. Answer any **3 (three)**. All questions carry equal marks. Marks in the margin indicate full marks. All symbols carry their usual meanings.

Q. 1. a) Explain in short, the necessity of unit commitment and de-commitment in economic power system operation. How is it different than economic load dispatch? 05

b) For a three-unit thermal power plant the following data are given: 20

$P_{g,min}$ (MW)	$P_{g,max}$ (MW)	Heat Rate (MBtu/h)	Fuel Cost ($/MBtu)
200	500	$510+7.2P_{g1}+0.00142P_{g1}^2$	1.05
80	350	$310+7.85P_{g2}+0.00194P_{g2}^2$	1.02
100	420	$78+7.97P_{g3}+0.00482P_{g3}^2$	1.10

Consider a demand of 800 MW.

i) Find out the feasible unit combinations for the given demand.
ii) Prepare a priority list ordering among the units based on full load average production cost.

Q. 2. a) Explain the following terms with respect to engineering optimization: (i) mixed integer nonlinear programming, (ii) convex optimization. 05

b) A two-region interconnected power system has a tie-line with a maximum real power handling capacity of 440 MW. The detail of the power generating units for each region is given below: 20

Region	Units	Unit Capacity (MW)	Unit Output (MW)	Regional Load (MW)
1	1	800	500	1000
	2	600	450	
2	3	1000	850	900
	4	300	100	

Examine the effect of unit outages (one unit at a time) on the spinning reserve of the system. Also, find out whether any of the unit outages would affect the power transmission through the tie-line.

Q. 3. a) Discuss with appropriate equations, the concepts of hot start-up and cold start-up costs. 05

b) Consider two thermal units with the following cost functions: 20

$$C_1(P_{G1}) = 890+15P_{G1}+0.03P_{G1}^2 \quad \$/hr$$

$$C_2(P_{G2}) = 480+10P_{G2}+0.01P_{G2}^2 \quad \$/hr$$

If the demand is given as 950 MW, find out the economic dispatch from of the generators using *lambda iteration algorithm*. Also find the value of the incremental cost (λ).

Q. 4. a) Mention the difference between binding and non-binding constraints related to a constrained optimization problem. 05

b) The fuel cost functions of a two-generator power system are expressed as 20

$$C_1(P_{G1}) = 500 + 5.2P_{G1} + 0.003P_{G1}^2 \text{ , and}$$
$$C_2(P_{G2}) = 460 + 5.1P_{G2} + 0.002P_{G2}^2$$

The load demand is 500 MW and the corresponding generation limits are given as $100 \leq P_{G1} \leq 400\ MW$, and $150 \leq P_{G2} \leq 300\ MW$, respectively.
Applying the Karush-Kuhn-Tucker condition of optimality, find out the optimal generation outputs.