Ref. No. Ex/PG/EE/T/128C/2024

**M.E. Electrical Engineering First Year Second Semester Examination, 2024**

**Power System Operation**

**Time: Three Hours** **Full Marks: 100**

**(50 Marks for each part)**

**Use a separate Answer Script for each Part**

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## PART-I

**Answer any three questions**

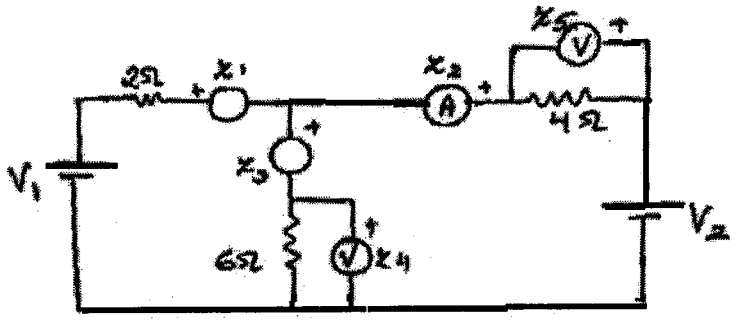
**2 marks reserved for well-organized answers**

1. a) Explain the principles of maximum likelihood criterion and weighted least square criterion for state estimation. [4]

b) Two resistances $R_1$ and $R_2$ are connected in parallel with a voltage source. Using maximum likelihood criterion, determine the value of the voltage source from the two ammeter readings of known standard deviations which connected in series with each resistance. [6]

c) Explain what do you understand by economic load dispatch in power system. Explain the significance of $B$ coefficients in connection with economic load dispatch. [3 + 3]

2. a) Discuss how bad data can be identified in a set of measurement data. [6]




b) In the circuit shown below, the readings of the ammeters $z_1$, $z_2$ and $z_3$ are 2A, -0.25A and 1.2A respectively. The readings of the voltmeters $z_4$ and $z_5$ are 11V and -1V respectively. Assume that ammeters $z_1$, and $z_2$ are 100% accurate and ammeter $z_3$ and the voltmeters are 75% accurate. Using the method of least squares determine the coefficient matrix H and the gain matrix G. Therefrom, explain how estimated values of the voltage sources $V_1$ and $V_2$ can be obtained. [10]

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3. a) What is the significance of penalty factor in economic load dispatch? Derive the formula for the penalty factor. [2 + 6]

b) Determine the optimal dispatch of generation for the three thermal plants having the following cost functions in Rs/ hr: [8]

$C_1 = 200 + 7P_1 + 0.008P_1^2$, $C_2 = 180 + 6.3P_2 + 0.009P_2^2$, $C_3 = 140 + 6.8P_3 + 0.007P_3^2$

Assume that the load is 150MW and the generator limits in MW are:

$10 \leq P_1 \leq 85$, $10 \leq P_2 \leq 80$, $10 \leq P_3 \leq 70$.

The real power loss is given by $P_L = 0.000218P_1^2 + 0.000228P_2^2 + 0.000179P_3^2$

Show calculations upto 2nd iteration only and consider the initial value of $\lambda$ as 8.

4. a) Discuss the major functions of energy management system in energy control centers. [8]

b) How is smart grid control center different from traditional energy control center? Explain the smart grid control center hierarchy. [8]

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# M.E. ELECTRICAL ENGINEERING 1ST YEAR 2ND SEMESTER EXAMINATION 2024

## POWER SYSTEM OPERATION

**Time:** Three Hours **Full Marks:** 100

(50 Marks for Each Part)

**Part - II**

(Use separate answerscript for each part)
Answer any two questions

1(a) From the LFC transfer function model of a single-area power system show, with necessary derivation, that the steady-state frequency deviation following a step load change $\Delta P_d$ depends on the speed governor droop. Also show that a change in command input $\Delta P_c = \Delta P_d$ can nullify the deviation. 7

(b) Two single-area power systems are connected by a tie-line to form a two-area system. With necessary derivation show how the LFC transfer function models of the two areas can be connected to develop the two-area LFC model. What do you understand by the term 'ACE'? Discuss its significance in multi-area LFC. 10

c) Two 50 Hz power systems having capacities of 500 MVA and 1000 MVA respectively are connected by a tie-line and have the following parameter values on their respective capacity base.

$R = 0.01$ pu and $B = 1.0$ pu

Calculate the steady-state change in frequency and tie-line power following a sudden drop of 50MW load in the 1st area. The symbols have their usual significance. Formulae used if any to calculate the above changes must be derived. 8

2(a) Explain the terms 'Base Point' and 'Participation Factor', and discuss their roles in real-time economic dispatch. 10

(b) Explain why UC schedule is necessary for power systems consisting of thermal power plants. Discuss the different transition costs considered in UC problem and mention their effects on UC schedule. With the relevant flow chart discuss how Dynamic Programming is used to solve UC problem 15

3(a) Explain why proper hydro-thermal coordination is necessary for economic operation of power system consisting of both thermal and hydro plants. Develop a mathematical formulation of short-term hydro-thermal scheduling problem and discuss a method of its solution. In this context explain the term 'pseudo price of water'. 10

(b) Develop the transfer function model of AVR loop of synchronous generator and therefrom show that a minimum loop gain is essential to achieve a specified static accuracy of the AVR output. 15