NIRMA UNIVERSITY

Institute:	**Institute of Technology**
Name of Programme:	**BTech in Electrical Engineering**
Semester:	**VI**
Course Code:	**3EE208ME24**
Course Title:	**Power System Operation and Control**
Course Type:	**Department Elective-II**
Year of Introduction:	**2024 – 25**

L	T	Practical component				C
		LPW	PW	W	S	
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Course Learning Outcomes (CLOs):

After successful completion of the course, student will be able to

1. suggest economic operation of load between generating stations **(BL2)**
2. analyse the effect of load variation on frequency of power system network **(BL4)**
3. select appropriate voltage control and reactive power compensation techniques **(BL5)**
4. appraise the monitoring and control aspects of the power system and estimate the operating states **(BL4)**

Contents: **Teaching Hours: 45**

Unit- I **Economic Operation of Power System** **16**

Introduction to economic load dispatch, economic distribution of load between the plants considering transmission losses, transmission loss as a function of plant generation, Kron's method of evaluating loss coefficients, penalty factor, Lambda-iteration method, Gradient method and Newton's method for economic load dispatch. Gradient method and Newton's method for optimal power flow

Unit – II **Load Frequency Control** **9**

Load frequency control and excitation voltage regulators of a turbo-generator, modeling of speed governing system, turbine and generator - steady state analysis and dynamic response, control area concept, proportional plus integral control, frequency dependence of load, droop control and power sharing, single and two area load frequency control, AGC in a restructured power system, challenges with respect to changing grid

Unit-III **Reactive Power and Voltage Control** **6**

Production and absorption of reactive power, methods of voltage control, shunt reactors, shunt capacitors, series capacitors, synchronous condensers, static VAR compensators and effect of tap changing transformers

Unit-IV **Power System State Estimation** **7**

Introduction and basic methods of state estimation, state estimation from non-linear measurements, static state estimation for power systems, state estimation process in power systems, bad data measurement, application of power system state estimation

Unit-V	**Monitoring and Control** Overview of energy control center function: SCADA systems, phasor measurement units, wide area management system	**4**
Unit-VI	**Preventive, Emergency and Restorative control** Introduction, normal and alert state in a power system, emergency control, blackout, power system restoration	**3**

Self-Study:
The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

Laboratory Work:
This shall consist of at least 10 practical / simulations based on the above syllabus.

Suggested Readings:

1. T. K. Nagsarkar and M. S. Sukhija, Power System Analysis, Oxford University Press.
2. Prabha Kundur, Power System Stability and Control, Electric Power Research Institute, Power System Engineering Series.
3. John Grainger and W. D. Stevenson, Power System Analysis, McGraw Hill.
4. S. Sivanagaraju and G. Sreenivasan, Power System Operation and Control, Pearson.
5. D.P. Kothari and I. J. Nagrath, Modern Power System Analysis, McGraw Hill.
6. Hassan Bevrani, Masayuki Watanabe, Yasunori Mitani, Power System Monitoring and Control, John Wiley and Sons, Inc.
7. Federico Milano, Alvaro Ortega Manjavacas, Frequency Variations in Power Systems Modeling, State Estimation, and Control, Wiley - IEEE Press
8. Recent Research Publications.

Suggested List of Experiments:

Sl. No.	Title of Experiment	Hours
1	To develop the program using Lambda iteration method for optimum scheduling of thermal generators neglecting transmission losses	**2**
2	To develop the program using gradient method for optimum scheduling of thermal generators neglecting transmission losses	**2**
3	To develop the program for optimum scheduling of thermal generators with penalty factors	**4**
4	To develop the program for dynamic programming of unit commitment	**2**
5	To observe the effect of change in load on frequency in single area control using a mathematical model	**2**
6	To simulate load frequency dynamics of two area power system	**4**
7	To observe the effect of gradual load change on voltage profile and its improvement using suitable compensation in a two-bus system	**2**
8	To model and analyze a standard DC1A type IEEE excitation system	**2**
9	To determine bad data in power system measurements	**2**
10	To estimate the power system parameters using state space method	**2**

L = Lecture, T = Tutorial, P = Practical, C = Credit