NIRMA UNIVERSITY

Institute:	**Institute of Technology**
Name of Programme:	**B.Tech. in Electrical Engineering**
Semester:	**VII**
Course Code:	**2EE701**
Course Title:	**Power System Operation and Control**
Course Type:	(√ **Core**/ □ Value Added Course / □ Department Elective / □ Institute Elective/ □ University Elective/ □ Open Elective / □ Any other)
Year of Introduction:	**2021 – 22**

Credit Scheme

L	T	Practical component				C
		LPW	PW	W	S	
2	0	2	-	-	-	3

Course Learning Outcomes (CLOs):

At the end of the course, students will be able to-

1. suggest economic dispatch of load between generating stations
2. analyze the effect of load variation on frequency of power system network
3. select appropriate voltage control and reactive power compensation techniques and appraise the monitoring and control aspects of the power system
4. estimate the operating state of the power system

Syllabus: **Total Teaching Hours: 30**

Unit	Syllabus	Teaching hours
Unit-I	**Economic Operation of Power System** Introduction and concepts of economic load dispatch, economic distribution of load between the plants coordinating transmission losses, transmission loss as a function of plant generation, Kron's method of evaluating loss coefficients, Penalty factor.	**06**
Unit-II	**Load Frequency Control** Load frequency control and excitation voltage regulators of a turbo-generator, modelling of speed governing system, turbine and generator - steady state analysis and dynamic response, control area concept, proportional plus integral control, frequency dependency 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.	**06**
Unit-III	**Reactive Power and Voltage Control** 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.	**05**
Unit-IV	**State Estimation** Introduction, 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 in measurement, application of power system state estimation.	**07**

Unit-V	**Monitoring and Control** Overview of energy control centre function: SCADA systems, phasor measurement units, wide area management system.	**03**
Unit-VI	**Preventive, Emergency and Restorative control** Introduction, normal and alert state in a power system, emergency control, blackout, power system restoration.	**03**

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

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

Suggested Readings/ References:

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:

1. To develop the program code for optimum loading of generators neglecting transmission losses.
2. To develop the program code for optimum loading of generators with penalty factors.
3. Modelling of single area load frequency control with and without controller.
4. Simulation of load frequency dynamics of two area power systems.
5. Simulation of a sample power system for analysing improvement in voltage profile at various buses.
6. Modelling of the excitation system in software environment.
7. Modelling of FACTS devices to control various parameters in the power system.
8. To estimate the power system parameters using weighted least square method and compute gain and coefficient matrix [H].
9. To build the program code for chi-square method and determine bad data in power system measurements.
10. Analysing power system security problems and determination of parameter violations.

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