

Branch Name:	Electrical Engineering
Program Code:	ET109
Course Name:	Department Elective-IV: Power System Operation and Control
Course Code:	1ET1090804
Pre-requisite Course:	Basic understanding of structure of the power system and power system analysis.

Course Objectives:

1. This subject deals with the fundamentals for effective operation and control of the power system.
2. It highlights the functions carried out by load dispatch centre.
3. Regulated and De-regulated power system operational scenarios.
4. Students will get basic concepts about power system security.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)								
Lecture	Tutorial	Practical	Credit	Theory				Practical				Total
				University Assessment		Continuous Assessment		University Assessment		Continuous Assessment		
				Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
3	-	-	3	28	70	12	30	-	-	-	-	100

Course Contents:

Sr. No.	Topic	Total Hours	Weightage (%)
1	Automatic generation and voltage control: Introduction; Load Frequency Control (Single Area Case); Load Frequency Control and Economic Dispatch Control; Two-Area Load Frequency Control; Optimal (Two-Area) Load Frequency Control; Automatic Voltage Control; Load Frequency Control with Generation Rate Constraints (GRCs); Speed Governor Dead-Band and Its Effect on AGC; Digital LF Controllers; Decentralized Control.	8	15%
2	Power system security: Introduction; System State Classification; Security Analysis; Contingency Analysis.	8	15%
3	Reactive power and voltage control: Introduction; Reactive power requirement of an uncompensated line; Implication of surge impedance loading; Operation of a transmission line at no load condition; Operation of a transmission line under heavy loading condition; Voltage regulation of the transmission line and its relation with reactive power; Maximum power transfer in an uncompensated line; Line load-ability. Reactive power-voltage (Q-V) coupling concept; Governing effects on reactive power flow; Relation between voltage and reactive power at a node in a power system; Reactive power requirement for	12	20%

	control of voltage in long lines; Operational aspects in reactive power and voltage control; Basic principle of system voltage control; Reactive power flow constraints and their implications in loss of voltage; Effect of transformer tap changing in the post disturbance period; Effect of generator excitation adjustment in the post disturbance period; Practical aspects of reactive power flow problems leading to voltage collapse in EHV lines.		
4	Basics of state estimation: Introduction; Least Squares Estimation: The Basic Solution; Static and Tracking State Estimation of Power Systems; Some Computational Considerations; External System Equivalency; Treatment of Bad Data; Network Observability and Pseudo-Measurements; Application of Power System State Estimation.	12	20%
5	Power system load forecasting: Introduction; Forecasting Methodology; Estimation of Average and Trend Terms; Estimation of Periodic Components; Estimation of $y_s(k)$: Time Series Approach; Long-Term Load Predictions Using Econometric Models; Reactive Load Forecasting.	08	15%
6	Introduction to power system deregulation and restructuring: Introduction; Motivation for Restructuring of power system; Electricity market entities and model; Benefits of Deregulation; Basic terminologies; Deregulation – International scenario; Milestones of deregulation in the world; Indian power sector – Past and present status: Growth of power sector in India – An overview, A time line of the Indian power sector, Players in the Indian power sector, Research and professional bodies.	08	15%

Reference Books:

1. Modern Power System Analysis – D. P. Kothari, I. J. Nagrath, TMH Publication, 5th edition, 2009.
2. Power System Analysis – J. J. Grainger, W.D. Stevenson, Mc-GrawHill series publication, 2005.
3. Power Generation Operation and Control – A. J. Wood, B. F. Woolenber, John Wiley and Sons, 2013.
4. Advanced Power System Analysis and Dynamics – L. P. Singh, New Age International, sixth edition, 2006.
5. Operation of Restructured Power Systems – K. Bhattacharya, H. J. Bollen, J. E. Daalder, Kluwer academic publishers, 2001.

List of Open Source Software/learning website:

1. <http://nptel.ac.in/courses/108101040/>
2. <http://www.electrical-engineering-portal.com/>

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Understand the techniques to control power flows, frequency and voltage.	2 Understanding
CLO2	Explore the significance of power system restructuring.	4 Analyze
CLO3	To know the system state estimation and explore its importance.	1 Remembering

CLO4	Learn the power system security and its application as a system operator.	2 Understanding 3 Applying
CLO5	Carry out load forecasting using available methods.	5 Evaluating
CLO6	To analyze power system deregulation and restructuring	4 Analyze

Mapping of CLOs with POs & PSOs

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO1		L			M					L			M			
CLO2			L	H		M		M				L	L			L
CLO3							M		L		M	M			L	
CLO4	L				L		H	L			L			L		
CLO5				M						M					H	L
CLO6	H						L					M		M		

H: High, M: Medium, L: Low