

GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRICAL ENGINEERING (09) POWER SYSTEM OPERATION AND CONTROL SUBJECT CODE: 2180909 B.E. 8th SEMESTER

Type of course: Engineering Science (Electrical)

Prerequisite: Basic understanding of structure of the power system and power system analysis.

Rationale: Demand of electrical energy is increasing day by day due to improvement in the life style of the people in particular and development of the countries in general. On the other hand, conventional sources of power generation are limited. Under this scenario, the power system network operates in a stressed condition. Effective management of generation, transmission and distribution of electrical power is necessary for optimal system operation, for loss minimization and to avoid the unwanted power cuts. This subject deals with the fundamentals for effective operation and control of the power system.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
PA	ALA	ESE		OEP						
4	0	0	4	70	20	10	0	0	0	100

Content:

Sr. No.	Content	Total Hrs	% Weightage
1.	Automatic Generation and Voltage Control: Introduction; Load Frequency Control (Single Area Case); Load Frequency Control and Economic Despatch 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; Reactive loss characteristics of transmission line; 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 loadability. 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 control of voltage in long lines;	12	20 - 25

	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.	State Estimation: Introduction; Least Squares Estimation: The Basic Solution; Static State Estimation of Power Systems; 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 - 25
5.	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.	8	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.	8	15

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	Total
15	25	30	15	15	100

Legends: R : Remembrance ; U = Understanding; A = Application; N = Analyze; E = Evaluate (Revised Bloom's Taxonomy)

NOTE : This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

Reference Books:

1. Modern Power System Analysis – D. P. Kothari, I. J. Nagrath, TMH Publication
2. An introduction to Reactive Power Control and Voltage Stability in Power Transmission Systems – A Chakrabarti, D P Kothari, A K Mukhopadhyay, Abhinandan De, PHI
3. Electrical Power Systems – P. Venkatesh, B.V. Manikandan, S.C. Raja, A. Srinivasan, PHI
4. Power System Analysis – J. J. Grainger, W.D. Stevenson, Mc-GrawHill series publication
5. Power Generation Operation and Control – A. J. Wood, B. F. Woolenber, John Wiley and Sons
6. Power System Analysis – Hadi Saadat, Mc-GrawHill series publication
7. Advanced Power System Analysis and Dynamics – L. P. Singh, New Age International
8. Operation of Restructured Power Systems – K. Bhattacharya, H. J. Bollen, J. E. Daalder, Kluwer academic publishers
9. <http://nptel.ac.in/courses/108101040/> (PSOC webcourse)

Course Outcome:

After learning the course the students should be able to:

- Understand the techniques to control power flows, frequency and voltage.
- Explore the significance of power system restructuring.
- Perform system state estimation and explore its importance.
- Learn the power system security and its application as a system operator.
- Carry out load forecasting using available methods.

List of Open Source Software/learning website:

- <http://nptel.ac.in/courses/108101040/>
- <http://www.electrical-engineering-portal.com/>
- <http://nptel.iitm.ac.in/courses.php>
- www.vlab.co.in

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should be submitted to GTU.