GUJARAT TECHNOLOGICAL UNIVERSITY
Bachelor of Engineering
Subject Code: 3170919
SUBJECT NAME: Power System Operation and Control
B.E. 7TH SEMESTER

Type of course: Professional Elective Course

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. 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. After the study of power system analysis, the study of power system operation is required. The understanding of automatic generation and control, reactive power characteristics of transmission lines and voltage control, state estimation, load forecasting and restructuring is desired.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	PA (V)	PA (I)	
3	0	0	3	70	30	00	00	100

Content:

Sr. No.	Content	Total Hrs
1.	**Automatic Generation Control 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);	8
2.	**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; 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; Power System Voltage Stability : Introduction, Difference between angle stability and voltage stability, Causes of voltage instability, types, proximity and mechanism of voltage stability, Practical aspects of reactive power flow problems leading to voltage collapse in EHV lines.	10
3.	**Power System Security:** Introduction; System State Classification; Security Analysis; Contingency Analysis; Sensitivity Factors: generation shift distribution factor, line shift distribution factor	6
4.	**State Estimation:**	8

	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	
5.	**Load Forecasting:** Introduction; Forecasting Methodology; Estimation of Average and Trend Terms; Estimation of Periodic Components; Estimation of $y_s(k)$: Time Series Approach; Estimation of Stochastic Component: Kalman Filtering Approach; Long-Term Load Predictions Using Econometric Models; Reactive Load Forecasting.	6
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.	4

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**Total**
5	10	10	25	20	70

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

(Question paper should have 20 to 35 marks for numerical problems based on design or analysis)

Reference Books:

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

Sr No.	Course Outcome Statement	Marks % weightage
CO-1	Apply concepts of frequency control and voltage control in small sample single area power system	25

CO-2	Analyse performance of transmission lines with respect to reactive power requirement for voltage stability	30
CO-3	Estimate the state of small sample power system	25
CO-4	Describe concepts of power system security and load forecasting	20

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