GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160920
Semester – VI
Subject Name: Inter Connected Power System

Type of course: Professional Elective Course

Prerequisite: Power Systems-I and Power Systems-II

Rationale: This subject is offered to study of behavior of power systems during normal operating conditions and/or when subjected to disturbances by mathematical modeling of components of power systems. It also briefs the students about the modeling of power systems networks for steady state analysis. They will also learn the economic operation and planning of power system network and also use the knowledge for the selection of components like Circuit Breaker for Power system protection.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Introduction:** Concept of Interconnection, Hierarchical Grid arrangements, Regulatory framework Cascade Tripping, Islanding, Load dispatch centre,	3
2	**Power system matrices** Brief explanation of Graph theory, Primitive Network, Ybus formation methods, Singular transformation method, Direct method, effect of addition and deletion of shunt elements on YBus, Numerical	4
3	**Load flow studies** Introduction, Bus Classifications, formation of Static Load Flow Equations (LFE), Approximate method of solution of LFE, Application of Numerical method for solution of nonlinear algebraic equations - Gauss-Seidel Method, Newton Raphson Method, Fast Decoupled Load Flow Method, Comparison of different methods of solution of load flow equations, Numerical,	12
4	**Economic operation of power systems** Generator operating cost, Economic operation of generators within thermal plant, Optimal operation by co-ordination equation, Penalty factor, Derivation of transmission loss formula (Kron's method), Unit commitment problem solution by dynamic programming, Numerical, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically	08

	Integrated, Purchasing Agency.	
5	**Frequency and voltage control methods** Speed governing mechanism, Mathematical modeling, Adjustment of Governor characteristics, Single area control, Flat frequency control, Selective frequency control, Tie line load bias control, Methods of voltage control, Numerical,	**06**
6	**Power system stability** Introduction, Mechanics of angular motion, The swing Education, transfer reactance, power relations, Steady state stability, Synchronizing power coefficient, Analysis of steady state stability, steady state stability with automatic voltage regulators, concept of shunt fault, transfer reactance during fault, reduction of power system to one machine connected to infinite bus, Transient stability, simplified transient generator model, The equal area stability criterion, solution of swing equation, Numerical	**12**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**30**	**20**	**25**	**10**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (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, Tata McGraw-Hill Education,
2. Power System Analysis and Stability, S.S. Vadhera, Khanna Publication
3. Power System Analysis, Hadi Saadat, Tata McGraw-Hill Education
4. Computer Aided Power System Analysis, G.L. Kusic, © 1986
5. Elements of Power System Analysis by William D. Stevenson McGraw-Hill
6. O. I. Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995.
7. A. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.

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Course Outcomes:

At the end of this course, students will have the ability to

Sr. No.	CO statement	Marks % weightage
CO-1	Define the actual power system structure scenario and its operating mechanism in a state and country with major entities and their functions	**10**
CO-2	Develop proper mathematical model of transmission network for analysis of power flow study, form Static Load Flow Equations, Select and identify the most appropriate numerical technique Solving SLFE	**25**
CO-3	Demonstrate the methods used for voltage and frequency regulation in electrical power network by mathematical analysis	**20**
CO-4	Solve the Unit Commitment problem using Dynamic programming techniques. Analyze the power system economics and factors effecting the economic load dispatch with and without considering network loss	**20**
CO-5	Demonstrate the factors which determine steady state and transient angle stability. Analyze the same for a single machine/infinite bus system using both analytical and graphical (Equal area) methods. Apply numerical technique for stability study	**25**

List of Experiments:

1. To study the Ybus formation with the help of simple study system
2. To formulate Static Load Flow Equations of few simple sample study systems
3. To obtain solution of some small study system using approximate load flow method
4. To obtain solution of some small study system using G-S method
5. To obtain solution of some small study system using N-R method
6. To obtain solution of a study system using FDLF method
7. To obtain unit commitment of a power plant
8. To obtain economic load dispatch of power plant

9. To obtain economic load dispatch of generators considering transmission losses

10. To apply analysis of various principles of Load Frequency control with the help of numerical problems

11. To apply analysis of various principles of Power system angle stability with the help of numerical problems

12. To determine stability of a small system using numerical method.

Hands-on and computational experiments related to the course contents. This should include programming of numerical methods for solution of the power flow problem, economic load dispatch, Load frequency control and stability analysis.

Visit to load dispatch centre is suggested

Major Equipment: Not Applicable

List of Open Source Software/learning website:

https://nptel.ac.in