

Branch Name:	Electrical Engineering
Program Code:	ET109
Course Name:	Interconnected Power System
Course Code:	1ET1090702
Pre-requisite Course:	Basic understanding of structure of the power system and power system analysis

Course Objectives:

1. Students will acquire the knowledge regarding Load flow analysis of power system.
2. The modelling of power system components and networks for steady state analysis included in this course.
3. Students will get basic concepts of economic operation of power system.
4. Stability study of power system operating conditions illustrated briefly in this course.

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	-	2	4	28	70	12	30	12	30	08	20	150

Course Contents:

Sr. No.	Topic	Total Hours	Weightage (%)
1	Introduction: Concept of Interconnection, Hierarchical Grid arrangements, Cascade Tripping, Islanding, Load dispatch center, Power Generation Scenario in Gujarat and India.	02	05
2	Power system matrices: Brief explanation of Graph theory, Primitive Network, Y-bus formation methods, Singular transformation method, Direct method, Removal of elements, Algorithm for formation of Z-bus matrix addition of branch and link, Numerical.	06	14
3	Load flow studies: Introduction, Static Load Flow Equations, Formation of Load Flow Equations, Approximate method of solution of Load Flow Equations, Bus Classifications, Approximate method, Gauss-Seidel Method, Newton Raphson Method, Fast Decoupled Load Flow Method, Comparison of different methods, Numerical.	10	24

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 integrated, Purchasing Agency).	06	14
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	14
6	Power system stability: Introduction, Mechanics of angular motion, The swing Equation, 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	29

Reference Books:

1. Modern Power System Analysis, D. P. Kothari, I. J. Nagrath, Tata McGraw-Hill Education, 2018.
2. Power System Analysis and Stability, S.S. Vadhera, Khanna Publication, 2014.
3. Power System Analysis, Hadi Saadat, Tata McGraw-Hill Education, 2009.
4. Elements of Power System Analysis by William D. Stevenson McGraw-Hill, 2001.

List of Experiments:

1. Formation of Primitive, incidence Y-bus and Z-bus matrix for given network.
2. Derivation of static load flow equation for a sample 4-bus system.
3. Solution of static load flow equation using approximate method.
4. Solution of static load flow equation using Gauss-Seidel Method.
5. Solution of static load flow equation using Newton Raphson Method.
6. Solution of static load flow equation using Decoupled Load Flow Method.
7. Solution of static load flow equation using Fast Decoupled Load Flow Method.
8. To find most economical generation schedule of various units of a given power plant without losses.
9. To find most economical generation schedule of various units of a given power plant with losses.
10. To find the steady state stability of the system for various disturbances in power system.
11. Find the penalty factor for the given system.

List of Open Source Software/learning website:

- <https://nptel.ac.in/courses/108101040/2>
- <http://www.pserc.cornell.edu/matpower/>

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

CLO	Description	Bloom's Taxonomy Level
CLO1	To model the modern power system network.	2 Understanding
CLO2	To solve the problem of power flow for small or large size power system network.	3 Applying
CLO3	To determine the most economical generation schedule of power plant.	4 Analyze
CLO4	To determine the stability limits of a power system and Solve swing equation.	4 Analyze 3 Applying
CLO5	To identify economical generation of power and rescheduling of power	2 Understanding
CLO6	Find the variation in the frequency because of change in generation.	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	H							L	M				L	
CLO2				L		M						L	M			
CLO3					L		M		M		M	M	L			L
CLO4	L		M		H			M			M				L	
CLO5						L		H	L	M				L		
CLO6	H	M			L		L					M			H	L

H: High, M: Medium, L: Low