Power System Analysis

Code	CreditHours
EE-863	3-0

CourseDescription

This postgraduate course provides an in-depth exploration of power system analysis, covering theoretical foundations and practical applications in electrical engineering. Students will delve into the principles of power flow analysis, fault analysis, and stability analysis in interconnected power systems. Topics include modeling of transmission lines, generators, and loads, as well as advanced techniques like optimal power flow and dynamic simulation. The course emphasizes the application of computational tools and software for analyzing complex power systems, addressing challenges such as grid integration of renewable energy sources and mitigating grid disturbances. Practical sessions and case studies enable students to apply theoretical concepts to real-world scenarios, preparing them for roles in power system planning, operation, and research.

Textbook:

1. Grainger, John J., and William D. Stevenson, Power system analysis, New York: McGraw-Hill, 1994. (latest edition)
2. HadiSadaat, Power system analysis,(latest edition) McGraw-Hill, Schaum's series, 1999.

ReferenceBook:

1. P. Sauer and M. Pai, Power system dynamics and stability, Prentice Hall, 1998. (latest edition)
2. A. R. Bergen and V. Vittal, Power systems analysis, Second Edition, Prentice-Hall, 2000.

Prerequisites

1. Steady-state analysis of single-phase and three-phase circuits
2. Elements of transient analysis and basics electromagnetic field theory
3. Principles of electric machines, transformers, and transmission lines
4. Per-unit system and representations
5. Please also review Linear Systems for definition of a vector, a matrix, matrix sum and products, determinants, matrix inverse

ASSESSMENTSYSTEMFORTHEORY

Quizzes	10-15%
Assignments	5-10%
MidTerms	25-30%
Project	5-10%
ESE	45-50%

TeachingPlan

Week No	Topics	LearningOutcomes
1	Introduction	Overview of courseOutline,objectives,teachingplan,assessmentmethod, basic concepts of power system operations.
2-3	Per unit system	Explain the concept and advantages of the per unit system in electrical engineering, particularly in the context of transformers and power system analysis. Apply the per unit system to normalize and analyse electrical quantities in transformer circuits, facilitating easier calculation and comparison of system components. Understand the brute force method as an approach to solving optimization problems by evaluating all possible solutions systematically. Apply the brute force method to identify optimal solutions in power system scheduling or load allocation problems, considering computational efficiency and solution accuracy.
4-5	Unit Commitment	Evaluate the priority list method as a heuristic approach for solving scheduling or sequencing problems in power system operation, considering constraints and priorities. Implement the priority list method to optimize task allocation or resource scheduling in power system management, ensuring efficient use of resources and meeting operational objectives.
6	Economic Operation,	Understand the principles and applications of the Lagrange multiplier method in optimization problems, particularly in power system economics and dispatch. Apply the Lagrange method to formulate and solve constrained optimization problems in power system operations, considering variables like generation, transmission limits, and economic objectives. Analyse the impact of transmission losses on economic dispatch in power systems and formulate optimization models to minimize total generation costs including losses. Implement computational techniques and algorithms to achieve optimal load dispatch solutions that account for both generation constraints and transmission line losses
7-8	Power flow analysis	Understand the different types of transmission line models used in power system analysis, including lumped parameter models and distributed parameter models. Analyse the characteristics of transmission lines such as resistance, inductance, capacitance, and conductance, and their impact on power flow and stability in the system.Explain the concept of the bus admittance matrix in power system analysis, including its construction from line and transformer data. Apply the bus admittance matrix to solve power flow problems using iterative methods, understanding its role in representing nodal voltages and currents in the system.Describe the Gauss-Seidel method as an iterative technique for solving systems of linear equations, particularly in the context of power flow calculations.Implement the Gauss-Seidel

		method to solve power flow equations iteratively, analyzing convergence criteria and computational efficiency.Understand the Newton-Raphson method as a nonlinear iterative technique for solving power flow equations in electrical networks.Apply the Newton-Raphson method to solve power flow problems, considering its advantages in handling complex network configurations and convergence issues.
9	**MIDTERMEXAM**	
10-12	Fault Analysis	Understand the characteristics and classifications of symmetrical, unsymmetrical, line-to-line, line-to-ground, and double line-to-ground faults in electrical power systems.Calculate fault currents, analyse voltage conditions, and assess the impacts of each fault type on power system stability and equipment protection.Develop comprehensive fault analysis skills to design effective protection schemes, minimize downtime, and ensure safe and reliable operation of power distribution and transmission networks.
13-17	Sequence Networks and Stability Analysis	Detail overview of power sequence networks, negative sequence networks, zero sequence networks, synchronous machine connected to infinite bus, swing equations.
18	**FINALEXAM**	