GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Masters

Branch: Electrical Engineering

Course / Subject Code: ME01000131

Course / Subject Name : Computer Techniques in Power System

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PCC

Prerequisite:	Interconnected Power System.
Rationale:	The "Computer Techniques in Power Systems" course equips students with essential computational skills and tools for analyzing and solving complex power system problems. This course discusses methods for power flow analysis, stability assessment, and fault analysis using computer-based simulations in detail. By leveraging modern software and programming techniques, students gain practical experience in modeling and optimizing power systems. These skills are crucial for developing innovative solutions to enhance the efficiency, reliability, and sustainability of electrical grids in the evolving energy landscape.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	Formulate and solve power flow problem for a given power system network
02	Apply various numerical methods for power system analysis
03	Analyze power systems by conducting short circuit studies, symmetrical fault analysis, and contingency study
04	Formulate model for state estimation with linear & nonlinear measurements and apply state estimation techniques to monitoring and optimization of power system operations

Teaching and Examination Scheme:

Teaching Scheme(in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Mathematical Preliminaries:** Gaussian Elimination, LU Factorization, Concept of Sparsity, Sparsity for Reducing Storage Requirements for Ybus and Jacobian, Ordering Schemes	3	05%
2.	**Power Flow Analysis:** Modeling of power system components**,** Power flow problem formulation, Bus classification and construction of Y-Bus, Gauss Siedel method, Newton Raphson method, De-Coupled method, Fast Decoupled method, Modified Fast Decoupled, Concept of Optimal Power Flow, Solution of Optimal power flow by Gradient method, Solution of Optimal power flow by Newton's method, Continuation Power flow	12	30%
3.	**Power System Security and Short Circuit Study:** Introduction, Factors Affecting Power System Security, Short Circuit Studies of a Large Power System Networks, Symmetrical Fault Analysis Using Bus Impedance Matrix (Zbus), Algorithm for Formation of Bus Impedance Matrix, Overview of Security Analysis, Contingency Analysis using Zbus by adding and removing multiple lines, Concept of Compensation Current, Analysis of Single Contingencies, Contingency Analysis by DC Model, Linear Sensitivity Factors, Contingency Selection, Concentric Relaxation, Bounding	11	25%
4.	**State Estimation in Power Systems:** Introduction, Power System State Estimation, Weighted Least Squares Estimation (WLSE) method with Linear Measurements, Inclusion of Statistics in WLSE, Maximum Likelihood Concept, State Estimation of AC network – Nonlinear Measurements, Development of Jacobian Matrix, State Estimation by Orthogonal Decomposition, Detection and Identification of Bad measurements using Chi-squared distribution, Estimation of quantities not being measured, Network Observability and Pseudo Measurements, Application of Power Systems State Estimation	12	25%
5	**Numerical Integration Techniques:** One step methods, Taylor series based methods, Forward -Euler's method, Runge-Kutta methods, Trapezoidal method, backward-Euler's method, Accuracy and error analysis, Numerical stability analysis, Power system applications: Transient stability analysis	7	15%
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	10	20	30	30	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1) Computer-Aided Power Systems Analysis (2nd Edition), George Kusic, CRC Press – Indian Edition
2) Computer Methods in Power System Analysis, Glenn Stagg and El-abiad, McGraw-Hill
3) Computational methods for Electric Power Systems, CRC press- Mariesa Crow
4) Power System Analysis by William Stevenson and John Grainger, McGraw Hill Education (India)
5) Electric Energy Systems Theory – An Introduction by Olle I. Elgerd, Tata McGraw Hills Education
6) Computer Techniques in Power System Analysis by Pai M. A., Tata McGraw hill, New Delhi, 2006
7) Computer analysis of power systems by Arrillaga, J and Arnold C.P, John Wiley and Sons, New York, 1997
8) Power Generation Operation and Control by Allen J. Wood and Bruce F. Wollenberg, John Wiley & Sons Inc, Second Edition

(b) Open source software and website:

1) Scilab, GNU Octave
2) NPTEL MOOC Course on "Computer Aided Power System Analysis" by Prof. Biswarup Das, IIT Roorkee
3) NPTEL Web Course on "Power System Stability" by Prof. B. Kalyan Kumar, IIT Madras

(c) List of Laboratory/Learning Resources Required:

1) Computer LAB equipped with MATLAB/ PSCAD /MiPower / PowerWorld Simulator software

(d) List of Experiments

1) To develop a program for the solution of linear algebraic equations using gauss elimination method.
2) To develop a programme for formation of Ybus matrix for given power system network using direct inspection method.
3) To develop a programme for solution of static load flow equation using Gauss-Seidel method of power

flow study.

4) To develop a programme for solution of static load flow equation using Newton Raphson method of power flow study.
5) To develop a programme for Solution of static load flow equation using Fast Decoupled Load Flow method.
6) To develop a computer programme for LU Factorization method.
7) To develop a computer programme to obtain sensitivity factor for power system security analysis.
8) To develop a computer programme for solving power system state estimation problem using WLSE technique with linear measurements.
9) To develop a computer programme for solving power system state estimation problem using WLSE technique with nonlinear measurements.
10) To simulate contingency analysis for given power system network using PowerWorld Simulator/ MiPower Software.
11) To simulate symmetrical & unsymmetrical fault for a given power system network using PowerWorld Simulator/ MiPower Software
12) To develop a computer programme for to Zbus for a sample power network.

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