IV Year B.Tech. EEE I-Semester

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POWER SYSTEMS ANALYSIS

Prerequisite: Power Systems I and Power system II.

Course Objectives:

1. To understand and develop Ybus and Zbus matrices.
2. To know the importance of load flow studies and its importance.
3. To analyze various types of faults occur in power system.
4. To know Steady State and Transient stability of power system.
5. To understand the economic operation of the Thermal power plants.
6. To know the importance of Load frequency control

UNIT – I: (~10 Lecture Hours)

Power Flow Studies: Network Matrices. Transmission Network Representations: Bus Admittance frame and Bus Impedance frame. **Formation of Y_{BUS}:** Direct Method only, Formation of Z_{BUS} from Y_{BU}, Numerical Problems. Necessity of Power Flow Studies, Bus classification and Notations, Convergence & Bus mismatch criteria.

Load Flow Methods: Gauss-Seidal method, Newton Raphson method in Polar and Rectangular form, Numerical Problems for one or two iterations.

UNIT – II:(~9 Lecture Hours)

Short Circuit Analysis: Per-Unit equivalent reactance network of a three phase Power System, Numerical Problems.

Symmetrical fault Analysis: Short Circuit Current and MVA Calculations, Fault levels, Application of Series Reactors, Numerical Problems. Symmetrical Components, sequence impedances and networks, Numerical Problems.

Unsymmetrical Fault Analysis: Fault current calculations for LG, LL, LLG faults with and without fault impedance, Numerical Problems.

UNIT – III :(~10 Lecture Hours)

Power System Stability Analysis: Introduction to Power System Stability issues. Rotor dynamics & Swing equation, Power angle equation, Steady State Stability, Determination of Transient Stability through Equal Area Criterion for single machine infinite system, Critical clearing angle & time, Numerical problems.

Multi machine transient analysis: Classical representation of system and its assumptions, Solution of Swing Equation by Point-by-Point Method, Methods to improve Stability.

UNIT –IV: (~9 Lecture Hours)

Economic Operation of Power Systems: Optimal operation of Generators in Thermal Power Stations, - heat rate Curve — Cost Curve — Incremental fuel and Production costs, input-output characteristics, Optimum generation allocation with line losses neglected. Optimum generation

allocation including the effect of transmission line losses — Loss Coefficients, General transmission line loss formula.

UNIT-V: (~10 Lecture Hours)

Modeling of Governor, Turbine, Generator and Load: Mathematical Modeling of Speed Governing System — Derivation of small signal transfer function. First order Turbine model, Block Diagram representation of Steam Turbines and Approximate Linear Models. Generator and Load Model.

Single Area & Two Area Load Frequency Control: Necessity of keeping frequency constant, Definitions of Control area Single area control-Block diagram representation of an isolated power system — Steady state analysis, Dynamic response — Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation, steady state response. State variable model.

Load frequency control of two area system: Tie line Model , Block diagram representation of two area power system. Uncontrolled case-Steady state analysis only.

TEXT BOOKS:

1. I. J. Nagrath & D. P. Kothari "Modern Power system Analysis", Tata McGraw-Hill Publishing Company, 4th Edition 2011.
2. Dr. K.Uma rao, "Computer techniques and models in power system", I.K.International -2007.
3. Dr.K. Uma Rao "Power System operation and control", Wiley India Pvt. Ltd.

REFERENCE BOOKS:

1. Glenn W.Stagg, Ahmed H. El-Abiad, "Computer methods in power system analysis " , McGraw-Hill Publishing Company
2. Olle. I. Elgerd "Electric Energy Systems Theory – An Introduction", Tata McGraw Hill Publishing Company Ltd, New Delhi, 30th reprint, 2007.
3. C. L. Wadhwa, "Electrical power systems", New Age International (P) Limited Publishers, 7th edition, 2016.
4. John J.Grainer & W.D.stevenson "power system analysis" – McGraw Hill Education; 1st edition, July 2017.
5. Hadi Saadat, "Power System Analysis", 3rd edition TMH Edition, 2011.

Course Outcomes: After this course, the student will be able to:

1. Develop Y_{bus} , Z_{bus} matrices for the power system networks
2. Perform the load flow analysis of power system networks using Gauss-Seidel, Newton-Raphson methods.
3. Analyze symmetrical and unsymmetrical faults in power system networks.
4. Estimate the Transient and steady state Stability for single machine infinite system.
5. Apply mathematical techniques/methods to solve economic load dispatch problems.
6. Model and analyze the single and two area Load frequency control systems for the control of frequency.