B.Tech III Year II Semester

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

19AEE61- POWER SYSTEM OPERATION AND CONTROL

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Course Objectives:

- To determine the mathematical model of Power System and find the load flow of a given power system
- To perform fault analysis and determine the stability of the system.
- To understand about optimal power flow problems and solving using specified method
- To understand about Automatic Generation Control problems and solutions in Power Systems
- To understand necessity of reactive power control, compensation under no load and load operation of transmission systems.

UNIT – I: LOAD FLOW STUDIES 10 Hrs

Representation of Power System Elements, Ybus - Formation by Inspection Method, Modelling of Transformer (Off nominal turns ratio), Necessity of Power Flow Studies – Data for Power Flow Studies, Static Load Flow Equations – Load Flow Solutions using Gauss Seidel Method: Acceleration Factor, with P-V Buses, Algorithm and Flowchart, Newton Raphson Method in Polar Co-ordinates Form: with PV Buses, Jacobian Elements, Algorithm and Flowchart, Decoupled and Fast Decoupled Methods, Comparison of Different Methods, Numerical Problems .

Learning Outcomes:

At the end of this unit, the student will be able to

- Learn about representation of power system components. **L1**
- Learn about formation of Y bus. **L2**
- Learn about necessity of studyof load flows and various methods. **L3**

UNIT – II: SHORT CIRCUIT ANALYSIS 10 Hrs

Per-Unit System of Representation. Per-Unit Equivalent Reactance Network of a Three Phase Power System, Numerical Problems. Fault Analysis: Short Circuit Current and MVA Calculations, Fault Levels, Application of Series Reactors, Numerical Problems. Symmetrical Component Transformation, Positive, Negative and Zero Sequence Components: Voltages, Currents and Impedances. Sequence Networks: Positive, Negative and Zero sequence Networks, Numerical Problems. Unsymmetrical Fault Analysis: LG, LL, LLG faults with and without Fault Impedance, Numerical Problems.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand regarding the per unit system. **L1**
- Understand regarding Short ckt analysis and MVA calculations. **L2**
- Learn about Sequence networks. **L3**

UNIT – III: POWER SYSTEM STABILITY ANALYSIS 10 Hrs

Elementary Concepts of Steady State, Dynamic and Transient Stabilities. Description of: Steady State Stability Power Limit, Transfer Reactance, Synchronizing Power Coefficient, Power Angle Curve and Determination of Steady State Stability and Methods to Improve Steady State Stability.

Derivation of Swing Equation. Determination of Transient Stability by Equal Area Criterion, Application of Equal Area Criterion, Critical Clearing Angle Calculation. Solution of Swing Equation by 4th Order Range – Kutta Method (up to 2 iterations) - Methods to improve Stability.

Learning Outcomes:

At the end of this unit, the student will be able to

- Learn about various stabilities and definitions involved in stability. **L1**
- Learn about how to calculate steady state stability and methods to improve it. **L2**

- Learn about the concept of equal area ,Swing equation solution by various methods

UNIT – IV: ECONOMIC OPERATION OF POWER SYSTEMS **10 Hrs**

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. First Order Turbine Model, Block Diagram Representation of Steam Turbines and Approximate Linear Models. Modeling of Governor: Mathematical Modeling of Speed Governing System – Derivation of Small Signal Transfer Function – Block Diagram.

Learning Outcomes:

At the end of this unit, the student will be able to

- Learn about economic operation of power systems. **L1**
- Learn about B.D representation and Modelling of various components in P.S. **L2**

UNIT – V: LOAD FREQUENCY CONTROL and REACTIVE POWER CONTROL **10 Hrs**

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 and PI Controlled Case. Load Frequency Control of 2-Area System – Tie-Line Bias Control , Uncontrolled Case and PI Controlled Case. Steady State Response – Load Frequency Control and Economic Dispatch Control (AGC). Overview of Reactive Power Control – Reactive Power Compensation in Transmission Systems – Advantages and Disadvantages of Different Types of Compensating Equipment for Transmission Systems; Load Compensation – Specifications of Load Compensator, Uncompensated and Compensated Transmission Lines: Shunt and Series Compensation.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the necessity of keeping the frequency constant. **L1**
- Learn about calc. of steady state and Dynamic response of controlled and uncontrolled cases. **L2**
- Learn about power system compensation. **L3**

Text Books:

1. Power System Analysis Operation and Control-A.Chakravarthi and S.Halder,3rd Edition,PHI.
2. Modern Power System Analysis – by I.J.Nagrath&D.P.Kothari Tata M Graw – Hill Publishing Company Ltd, 2nd edition.

Reference Books:

1. An Introduction to: Reactive Power Control and Voltage Stability in Power Transmission Systems by AbhijitChakrabarti, D. P. Kothari
2. A. K. Mukhopadhyay and Abhinandan De, Eastern Economy Edition, 2010..
3. Power System Analysis and Design by J.Duncan Glover and M.S.Sarma., THOMPSON, 3rd Edition
4. Electric Power Systems by S. A. Nasar, Schaum's Outline Series, Revised 1st Edition, TMH

Course Outcomes:

At the end of this Course the student will be able to

- To form Y Bus and perform load flow and short circuit analysis **L1**
- To determine the transient and steady state stability of a given power system **L2**
- To be able to Understand to deal with AGC problems in Power System **L3**
- To understand the f control& complexity of reactive power control problems. **L4**
- To understand how the cost of generation per unit can be minimized **L5**