# POWER SYSTEM OPERATION AND CONTROL

**VII Semester: EEE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| AEE016 | Core | 3 | 1 | - | 4 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: 15 | Practical Classes: Nil | | | | Total Classes: 60 | | |

## COURSE OBJECTIVES:

**The course should enable the students to:**

I. Demonstrate economic operation of power systems, hydrothermal scheduling.
II. Illustrate modeling of turbines, generators and automatic controllers.
III. Discuss single area and two area load frequency control.
IV. Analyze reactive power control and load modeling.

## COURSE OUTCOMES (COs):

CO 1: Understand the optimal operation of generators in thermal power stations and their characteristics with and without transmission loss coefficient
CO 2: Design the mathematical models of the speed governing systems, turbine and excitation system.
CO 3: Discuss single area load frequency control and two area load frequency control.
CO 4: Discuss the need of power factor correction and voltage drop compensation and Identify the best methods for power factor improvement and voltage control.
CO 5: Understand the types of loads and their characteristics with specifications of load compensator.

## COURSE LEARNING OUTCOMES (CLOs):

1. Understand optimal operation of generators in thermal power stations and their characteristics.
2. Design an optimal operation setup of power system which minimizes operation costs and meet desired needs.
3. Solve the unit Commitment problem with various constraints using conventional optimization techniques and general transmission line loss formula.
4. Examine optimal scheduling of hydrothermal system characteristics and their economic operation.
5. Design the mathematical models of the mechanical and electrical components involved in the operation of power systems.
6. Understand the modeling of excitation systems and fundamental characteristics of an excitation system.
7. Design the single area and two area thermal power system.
8. Demonstrate the understanding of the open loop and closed loop control practices associated with the voltage and frequency control of single area or interconnected multi area power systems.
9. Understand the significance of reactive power control in power systems to maintain quality of power.
10. Design appropriate control scheme to compensate reactive power.
11. Describe the different methods of control and compensation to choose the best option so that social and environmental problems are minimized.
12. Describe the different methods of control and compensation recognize the need to continuously follow the advancements in technology and incorporate them in the present system to improve efficiency and increase the flexibility and quality of operation.
13. Differentiate the types of loads and their characteristics.

14. Calculate the voltage drop and power loss in a distribution system.
15. Apply the concept of power systems and operation and control to solve real time world applications.
16. Explore the knowledge and skills of employability to succeed in national and international level competitive examinations.

| UNIT-I | ECONOMIC OPERATION OF POWER SYSTEMS | Classes: 12 |
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Optimal scheduling of thermal power system: Optimal operation of generators in thermal power stations, heat rate curve, cost curve, incremental fuel and production costs, input output characteristics, optimum generation allocation without and with transmission line losses coefficients, general transmission line loss formula, unit commitment; Optimal scheduling of hydrothermal system: Hydro electric power plant models, scheduling problems, short term hydro thermal scheduling problem.

| UNIT -II | MODELING OF GOVERNOR, TURBINE AND EXCITATION SYSTEMS | Classes: 09 |
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Modeling of governor: Mathematical modeling of speed governing system, derivation of small signal transfer function; Modeling of turbine: First order turbine model, block diagram representation of steam turbines and approximate linear models; Modeling of excitation system: Fundamental characteristics of an excitation system, transfer function, block diagram representation of IEEE type-1 model.

| UNIT-III | SINGLE AREA AND TWO AREA LOAD FREQUENCY CONTROL | Classes: 09 |
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Load frequency control of single area system: 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.

Load frequency control of two area system: Uncontrolled case and controlled case, tie line bias control; Load frequency controllers: Proportional plus integral control of single area and its block diagram representation, steady state response, load frequency control and economic dispatch.

| UNIT-IV | COMPENSATION FOR POWER FACTOR IMPROVEMENT AND REACTIVE POWER CONTROL | Classes: 09 |
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Voltage control: Equipment for voltage control, effect of series capacitors, line drop compensation, effect of AVR, power factor control using different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (fixed and switched), power factor correction, capacitor allocation, economic justification, procedure to determine the best capacitor location; Reactive power control: Reactive power compensation in transmission systems, advantages and disadvantages of different types of compensating equipment for transmission systems; Uncompensated and compensated transmission lines: Shunt and series compensation.

| UNIT-V | LOAD COMPENSATION | Classes: 06 |
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Load Compensation: characteristics of loads, factors associated with loads, relation between the load factor and loss factor; specifications of load compensator; Classification of loads: Residential, commercial, agricultural and industrial and their characteristics.

**Text Books:**


1. C L Wadhwa, “Electrical power systems”, Newage International, 3rd Edition, 2005.
2. I J Nagarath, D P Kothari, “Modern power system analysis”, Tata McGraw-Hill, 2nd Edition, 2006.
3. T J E Miller, “Reactive power control in Electrical system”, Wiley Interscience Publication, 1982
4. V K Mehta and Rohit Mehta, “Principles of Power System”, S Chand, 3rd revised Edition, 2015

**Reference Books:**


1. Singh S N, "Electric Power Generation, Transmission and Distribution", Prentice Hall of India Pvt. Ltd., New Delhi, 2nd Edition, 2002.
2. Turan Gonen, "Electrical Power Distribution System Engineering", CRC Press, 3rd Edition, 2014.
3. V Kamaraju, "Electrical Power Distribution Systems", TMH, Publication, Edition, 2009.
4. O I Elgerd, "Electrical Energy Systems Theory", Tata McGraw-Hill, 2nd Edition, 2007


**Web References:**

1. https://www.electrical4u.com/working-or-operating-principle-of-dc-motor
2. https://www.freevideolectures.com
3. https://www.ustudy.in › Electrical Machines
4. https://www.freeengineeringbooks.com

**E-Text Books:**

1. https://www.textbooksonline.tn.nic.in
2. https://www.freeengineeringbooks.com
3. https://www.eleccompengineering.files.wordpress.com
4. https://www.books.google.co.in