



DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING LESSON PLAN

| Course Code | Course Title | Year/Sem | Branch | Contact Hrs/Week | Section |
|-------------|--|-------------|------------|------------------|------------|
| | FLEXIBLE ALTERNATING CURRENT TRANSMISSION SYSTEMS | IV/I | EEE | 6 | EEE |

COURSE OUTCOMES:

After the completion of the course the student should be able to:

- Know the concepts of facts controller and power flow control in transmission line.
- Demonstrate operation and control of voltage source converter and know the concepts current source converter.
- Analyze compensation by using different compensators to improve stability and reduce power oscillations in the transmission lines.
- Know the concepts methods of compensations using series compensators.
- Analyze operation of Unified Power Flow Controller (UPFC) and Interline power flow controller (IPFC).

| Unit No. | Out Comes | TOPIC(S) | BOOK Reference | Total periods | Delivery Method | GAT E/ IES | |
|-------------------------------------|---|----------|---------------------------------------|---------------|-----------------|--|-------|
| UNIT-I INTRODUCTION TO FACTS | | | | | | | |
| 1 | CO1: Know the concepts of facts controller and power flow control in transmission line. | 1.1 | Introduction to FACTS | T1, T2, R1 | 12 | Chalk & Talk, Active Learning & Tutorial | GAT E |
| | | 1.2 | Power flow in an AC System | T1, T2, R1 | | | |
| | | 1.3 | Loading capability limits | T1, T2, R1 | | | |
| | | 1.4 | Dynamic stability considerations | T1, T2, R1 | | | |
| | | 1.5 | Importance of controllable parameters | T1, T2, R1 | | | |

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|--|--|------|--|------------|--|--|--|
| | | 1.6 | Basic types of FACTS controllers | T1, T2, R1 | | | |
| | | 1.7 | Benefits from FACTS controllers | T1, T2, R1 | | | |
| | | 1.8 | Requirements and characteristics of high power devices | T1, T2, R1 | | | |
| | | 1.9 | Voltage and current rating | | | | |
| | | 1.10 | Losses and speed of switching | | | | |
| | | 1.11 | Parameter trade-off devices. | | | | |

UNIT - II VOLTAGE SOURCE AND CURRENT SOURCE CONVERTERS

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|---|--|-----|---|------------|----|---|--|
| 2 | CO2: Demonstrate operation and control of voltage source converter and know the concepts current source converter. | 2.1 | Voltage source converter (VSC) | T1, T2, R2 | 12 | Chalk & Talk, Tutorial, Active Learning | |
| | | 2.2 | Single phase full-wave bridge converter | T1, T2, R2 | | | |
| | | 2.3 | Square wave voltage harmonics for a single-phase bridge converter | T1, T2, R2 | | | |
| | | 2.4 | Three-phase full-wave bridge converter | T1, T2, R2 | | | |
| | | 2.5 | Transformer connections for 12 pulse operation. | T1, T2, R2 | | | |
| | | 2.6 | Current Source Converter (CSC) | T1, T2, R2 | | | |
| | | 2.7 | Three-phase current source converter | T1, T2, R2 | | | |
| | | 2.8 | Comparison of current source converter with voltage source converter. | T1, T2, R2 | | | |

UNIT - III SHUNT COMPENSATORS

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|---|--|-----|--|--------|----|--------------|--|
| 3 | CO3: Analyse compensation by using different compensators to | 3.1 | Shunt Compensators Objectives | T1, T2 | 12 | Chalk & Talk | |
| | | 3.2 | Mid-point voltage regulation for line segmentation | T1, T2 | | | |
| | | 3.3 | End of line voltage support to prevent voltage instability | T1, T2 | | | |
| | | 3.4 | Improvement of transient stability. | T1, T2 | | | |
| | | 3.5 | Power oscillation damping. | T1, T2 | | | |
| | | 3.6 | Variable Impedance | T1, T2 | | | |

| | | | | | | |
|---|------|---|--------|--|--|--|
| improve stability and reduce power oscillations in the transmission lines | | Type VAR Generator: Thyristor Switched/Controlled Reactor (TSR/TCR) | | | | |
| | 3.7 | Thyristor Switched Capacitor (TSC) | T1, T2 | | | |
| | 3.8 | Fixed Capacitor–Thyristor Controlled Reactor (FC-TCR) | | | | |
| | 3.9 | Thyristor Switched Capacitor and Thyristor Controlled Reactor (TSC–TCR) | | | | |
| | 3.10 | Switching Converter type VAR generator. | | | | |
| | 3.11 | Principle of operation and comparison of SVC and STATCOM. | | | | |

UNIT - IV SERIES COMPENSATORS

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|---|--|------|---|------------|----|------------------------|
| 4 | CO4: Know the concepts methods of compensations using series compensators. | 4.1 | Concept of series capacitive compensation | T1, T2, R3 | 12 | Chalk & Talk, Tutorial |
| | | 4.2 | Improvement of transient stability | T1, T2, R3 | | |
| | | 4.3 | Power oscillation damping | T1, T2, R3 | | |
| | | 4.4 | Functional requirements | T1, T2, R3 | | |
| | | 4.5 | Variable Impedance type series compensators | T1, T2, R3 | | |
| | | 4.6 | GTO Thyristor controlled Series Capacitor (GSC) | | | |
| | | 4.7 | Thyristor Switched Series Capacitor (TSSC) | | | |
| | | 4.8 | Thyristor Controlled Series Capacitor (TCSC) | | | |
| | | 4.9 | Switching Converter type Series Compensation | | | |
| | | 4.10 | Static Synchronous Series Compensator. | T1, T2, R3 | | |

UNIT - V COMBINED COMPENSATORS

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|---|--|--------------|--|--------|-----------|--|
| 5 | CO5: Analyse operation of Unified Power Flow Controller (UPFC) and Interline power flow controller (IPFC). | 5.1 | Schematic and basic operating principles of unified power flow controller (UPFC) | T1, T2 | 12 | Chalk & Talk, PPT Tutorial, Active Learning & Seminars |
| | | 5.2 | Interline power flow controller (IPFC) | T1, T2 | | |
| | | 5.3 | Controller applications of transmission lines. | T1, T2 | | |
| | | TOTAL | | | 60 | |

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|-----|--|---------------|----|
| CO1 | Know the concepts of facts controller and power flow control in transmission line. | UNDERSTANDING | K2 |
| CO2 | Demonstrate operation and control of voltage source converter and know the concepts current source converter. | APPLY | K3 |
| CO3 | Analyze compensation by using different compensators to improve stability and reduce power oscillations in the transmission lines. | ANALYZE | K4 |
| CO4 | Know the concepts methods of compensations using series compensators. | UNDERSTANDING | K2 |
| CO5 | Analyze operation of Unified Power Flow Controller (UPFC) and Interline power flow controller (IPFC). | ANALYZE | K4 |

CO-PO MAPPING: (1: Slight [Low]; 2: Moderate [Medium]; 3: Substantial [High]; ‘-’: No Correlation)

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1-K4 | 3 | 3 | 3 | - | 2 | 2 | 3 | - | 3 | - | 3 | 3 |
| CO2-K4 | 3 | 3 | 3 | - | 2 | 2 | 3 | - | 3 | - | 3 | 3 |
| CO3-K4, K5 | 3 | 3 | 3 | - | 2 | 2 | 3 | - | 3 | - | 3 | 3 |
| CO4-K5 | 3 | 3 | 3 | - | 2 | 2 | 3 | - | 3 | - | 3 | 3 |
| CO5-K5 | 3 | 3 | 3 | - | 2 | 2 | 3 | - | 3 | - | 3 | 3 |

| S.NO | GRADUATE ATTRIBUTION | ACTION VERBS | LEVEL |
|------|-----------------------------------|----------------|--------|
| 1 | ENGINEERING KNOWLEDGE | APPLY | K3 |
| 2 | PROBLEM ANALYSIS | ANALYZE | K4 |
| 3 | DESIGN DEVELOPMENT OF SOLUTIONS | APPLY | K3 |
| 4 | INVESTIGATION OF COMPLEX PROBLEMS | | |
| 5 | MODERN TOOL USAGE | APPLY | K3 |
| 6 | ENGINEER AND SOCIETY | APPLY | K3 |
| 7 | ENVIRONMENT AND SUSTAINABILITY | APPLY, ANALYZE | K3, K4 |
| 8 | ETHICS | | |
| 9 | INDIVIDUALS AND TEAM WORK | APPLY, ANALYZE | K3, K4 |
| 10 | COMMUNICATION | | |
| 11 | PROJECT MANAGEMENT AND FINANCE | APPLY | K3 |
| 12 | LIFE LONG LEARNING | APPLY | K3 |

Text Books:

| S.No. | AUTHORS, BOOK TITLE, EDITION, PUBLISHER, YEAR OF PUBLICATION |
|-------|--|
| 1. | “Understanding FACTS” N.G.Hingorani and L.Guygi, IEEE Press.Indian Edition is available:— Standard Publications, 2001. |

Reference Books:

| S.No. | AUTHORS, BOOK TITLE, EDITION, PUBLISHER, YEAR OF PUBLICATION |
|-------|---|
| 1. | “Flexible ac transmission system (FACTS)” Edited by Yong Hue Song and Allan T Johns, Institution of Electrical Engineers, London. |
| 2. | Thyristor-based FACTS Controllers for Electrical Transmission Systems, by R. Mohan Mathur and Rajiv K.Varma, Wiley. |

| | Name | Signature with Date |
|-----------------------|----------------------|---------------------|
| i. Faculty | Mrs. B Rohini | |
| ii. Class Coordinator | Mrs. R. Maha Lakshmi | |

HOD

PRINCIPAL