B.Tech IV Year I Semester

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

19AEE76a- HVDC AND FLEXIBLE AC TRANSMISSION SYSTEMS

(Professional Elective-IV)

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Course Objectives: The objectives of the course are to make the students learn about

- High voltage DC transmission systems
- To familiarize the students with the HVDC converters and their control systems
- To introduce students with the concept of various HVDC links.
- Flexible AC transmission systems
- Various configurations of the above, Principle of operation, Characteristics of various FACTS devices

UNIT – I: Introduction **10 Hrs**

Electrical Transmission Networks, Conventional Control Mechanisms-Automatic Generation Control, Excitation Control, Transformer Tap-Changer Control, Phase-Shifting Transformers; Advances in Power-Electronic Switching Devices, Principles and Applications of Semiconductor Switches; Limitations of Conventional Transmission Systems, Emerging Transmission Networks, HVDC and FACTS.

Learning Outcomes:

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

- Know about difference between HVDC and FACTS **L1**
- Know about limitations of conventional transmission systems **L2**

UNIT – II: High Voltage DC Transmission – I **10 Hrs**

Types of HVDC links - Monopolar, Homopolar, Bipolar and Back-to-Back, Advantages and disadvantages of HVDC Transmission, Analysis of Greatz circuit, Analysis of bridge circuit without overlap, Analysis of bridge with overlap less than 600 , Rectifier and inverter characteristics, complete characteristics of rectifier and inverter, Equivalent circuit of HVDC Link.

Learning Outcomes:

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

- To learn about various HVDC link configurations **L1**
- To develop equivalent circuit of HVDC link **L2**

UNIT – III: High Voltage DC Transmission – II **10 Hrs**

Desired features and means of control control of the direct current transmission link, Constant current control, Constant ignition angle control, Constant extinction angle control, Converter firing-angle control-IPC and EPC, frequency control and Tap changer control, Starting, Stopping and Reversal of power flow in HVDC links.

Learning Outcomes:

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

- To learn about various DC link control techniques **L1**
- To learn about starting, stopping and reversal of power flow in DC links **L2**

UNIT – IV: Flexible AC Transmission Systems-I **10 Hrs**

Types of FACTS Controllers, brief description about various types of FACTS controllers, Operation of 6-pulse converter, Transformer Connections for 12-pulse, 24-pulse and 48-pulse operation, principle of operation of various types of Controllable shunt Var Generation, Principle of switching converter type shunt compensator, principles of operation of various types of Controllable Series Var Generation, Principle of Switching Converter type series compensator.

Learning Outcomes:

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

- To understand principle of working and differences between various pulse configurations of various converters **L1**
- To understand the necessity of compensators **L2**

UNIT – V: Flexible Ac Transmission Systems-II **10 Hrs**

Unified Power Flow Controller (UPFC) – Principle of operation, Transmission Control Capabilities, Independent Real and Reactive Power Flow Control; Interline Power Flow Controller (IPFC) – Principle of operation and Characteristics, UPFC and IPFC control structures (only block diagram description), objectives and approaches of voltage and phase angle regulators

Learning Outcomes:

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

- To know more about advanced Power flow controllers **L1**
- To analyze the transmission control strategies **L2**

Text Books:

1. Narain G. Hingorani and Laszlo Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, IEEE Press, Wiley-Interscience, New Jersey, 2000.
2. E.W. Kimbark, Direct current transmission, Vol. I, Wiley Interscience, New York, 1971.

Reference Books:

1. K R Padiyar, FACTS Controllers in Power Transmission and Distribution, New Age International Publishers, New Delhi, 2007.
2. AnriqueAcha, Claudio R. Fuerte-Esquivel, Hugo Ambriz-Pérez and César Angeles Camacho, FACTS: Modelling and Simulation in Power Networks, John Wiley & Sons, West Sussex, 2004.
3. R Mohan Mathur and Rajiv K Varma, Thyristor-Based FACTS Controllers for Electrical Transmission Systems, IEEE Press, Wiley-Interscience, New Jersey, 2002.

Course Outcomes:

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

- The necessity of HVDC systems as emerging transmission networks **L1**
- Apply the knowledge of HVAC and HVDC transmission in power networks. **L2**
- Analyze the different modes of operation for six pulse and twelve pulse converter unit in the contest of HVDC system **L3**
- To obtain equivalent circuits of various HVDC system configurations **L4**
- Power Electronic devices to understand the necessity of reactive power compensation devices **L5**