

Semester-V

L-2 T-1 P-2 C-4

OEDEN0101A: Renewable Energy Technologies**Course Objectives:**

- To understand present and future scenario of world energy use.
- To understand fundamentals of solar energy systems.
- To understand basics of wind energy.
- To understand bio energy and its usage in different ways.
- To identify different available non-conventional energy sources.

Course outcomes (Cos):

At the end of the course, the student will be able to:

1. Understand present and future energy scenario of the world.
2. Understand various methods of solar energy harvesting.
3. Identify various wind energy systems.
4. Evaluate appropriate methods for Bio energy generations from various Bio wastes.
5. Identify suitable energy sources for a location.

Articulation Matrix:

(Program Articulation Matrix is formed by the strength of correlation of COs with POs and PSOs. The strength of correlation is indicated as 3 for substantial (high), 2 for moderate (medium) correlation, and 1 for slight (low) correlation)

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3
CO1	2	2	1	2	-	-	-	-	-	1	1	1
CO2	2	2	1	2	-	-	-	-	-	2	2	1
CO3	3	2	-	2	-	-	-	-	-	2	2	1
CO4	2	2	1	2	-	-	-	-	-	1	1	1
CO5	3	2	1	2	-	-	-	-	-	1	1	1

High-3 Medium-2 Low-1

UNIT-I: Introduction**9 Hours**

World Energy Use; Reserves of Energy Resources; Environmental Aspects of Energy Utilisation; Renewable Energy Scenario in India and around the World; Potentials; Achievements / Applications; Economics of renewable energy systems.

Unit-II: Solar energy**9 Hours**

Solar Radiation; Measurements of Solar Radiation; Flat Plate and Concentrating Collectors; Solar direct Thermal Applications; Solar thermal Power Generation Fundamentals of Solar Photo Voltaic Conversion; Solar Cells; Solar PV Power Generation; Solar PV Applications.

Unit-III: Wind Energy**9 Hours**

Wind Data and Energy Estimation; Types of Wind Energy Systems; Performance; Site Selection; Details of Wind Turbine Generator; Safety and Environmental Aspects.

Unit-IV: Bio-Energy**9 Hours**

Biomass direct combustion; Biomass gasifiers; Biogas plants; Digesters; Ethanol production; Bio diesel; Cogeneration; Biomass Applications.

Unit-V: Other Renewable Energy Sources

9 Hours

Tidal energy; Wave Energy; Open and Closed OTEC Cycles; Small Hydro-Geothermal Energy; Hydrogen and Storage; Fuel Cell Systems; Hybrid Systems.

Total 45 Hours

PRACTICALS

Total 75 Hours

Reference Books:

1. O.P. Gupta, Energy Technology, Khanna Publishing House, Delhi (ed. 2018)
2. Renewable Energy Sources, Twidell, J.W. & Weir, A., EFN Spon Ltd., UK, 2006.
3. Solar Energy, Sukhatme. S.P., Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
4. Renewable Energy, Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, U.K., 1996.
5. Fundamental of Renewable Energy Sources, GN Tiwari and MK Ghoshal, Narosa, New Delhi, 2007.
6. Renewable Energy and Environment-A Policy Analysis for India, NH Ravindranath, UK Rao, B Natarajan, P Monga, Tata McGraw Hill.
7. Energy and The Environment, RA Ristinen and J J Kraushaar, Second Edition, John Willey & Sons, New York, 2006.
8. Renewable Energy Resources, JW Twidell and AD Weir, ELBS, 2006.

List of e-Learning Resources:

1. https://www.solarpathshala.com/solar_pathshala/pathshala.php
2. <https://www.africanpowerplatform.org/resources/258-elearning-for-renewable-energy-higher-education-in-africa-role-potential-and-outlook.html>
3. <https://onlinelearning.theect.org/>
4. <https://www.coursera.org/courses?query=renewable%20energy>

Subject Expert

Academic Coordinator

HoD

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OEEDEN0102A Flexible AC Transmission System

Course Objectives:

- To enable the students, acquire a comprehensive idea on various aspects of FACTS systems
- To acquire the knowledge on Flexible AC Transmission System and its importance for FACTS devices.
- To understand the various FACTS controller's operation on FACTS systems.
- To gain Knowledge about STATCOM
- To explore the latest advancements and emerging technologies in Flexible AC Transmission Systems.

Course Outcomes:

The students will be able to

1. Understand the concept the FACTS controller.
2. Apply the importance of controllable parameters and benefits of FACTS controllers.
3. Analyze the shunt, series compensation and role of FACTS devices on system control.
4. Evaluate the functional operation and control of GCSC, TSSC and TCSC.
5. Create the principles, operation and control of UPFC and IPFC

Articulation Matrix:

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CO2	2	2	1	2	-	-	-	-	-	2	2	1
CO3	3	2	-	2	-	-	-	-	-	2	2	1
CO4	2	2	1	2	-	-	-	-	-	1	1	1
CO5	3	2	1	2	-	-	-	-	-	1	1	1

High-3 Medium-2 Low-1

Unit-I Introduction

06 Hours

FACTS Concept and General System Consideration: Transmission Interconnection, Flow of Power in an AC System, factors affecting the Loading Capability, Power Flow and Dynamic Stability Consideration of Transmission interconnection, Importance of controllable Parameters, FACTS Controller.

Unit-II Converters

9 Hours

Voltage-Sourced and Current-Sourced Converters: Basic Concept of Voltage-Sourced Converters, Single-Phase Full-Wave Bridge Converter Operation, Single Phase Leg Operation, Square-Wave Voltage Harmonics for SinglePhase Bridge, ThreePhase Full-Wave Bridge Converter. Sequence of Valve Conduction, Process in Each Phase-Leg, Transformer connection for 12-Pluse Operation, Three Level Voltage Sourced Converter, Pulse-Width Modulation Converter, Generalized Technique of Harmonic Elimination and Voltage Control. Basic Concepts of Current-Sourced Converters, Thruster-Based Converters (with Gate Turn-On), Current Sourced Converter with Turn-Off Devices, Current Sourced Versus Voltage Sourced Converters.

Unit-III Compensators

06 Hours

Static Shunt Compensators: SVC and STATCOM. Objectives of shunt Compensation, Methods of Controllable VAR Generation, Static VAR Compensators SVC and STATCOM, Comparison Between STATCOM and SVC, Static VAR System.

Unit-IV Series Type Compensators

06 Hours

Static Series Compensators: GCS, TSSC, TCSC and SSSC. Objectives of series Compensation, Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators, External (System) Control for Series Reactive Compensators.

Unit-V Voltage & Phase Angle Regulator

09 Hours

Static Voltage and Phase Angle Regulators; TCVR and TCPAR. Objectives of Voltage and Phase Angle regulators, Approaches to Thyristor Controlled Voltage and Phase Angle Regulators (TCVR and TCP ARS), Switching Converter-Based Voltage and Phase Angle regulator, Hybrid Phase Angle Regulators.

Unit-VI Controller

09 Hours

Combine Compensators (UPFC, IPFC) and Special Purpose FACTS Controllers' : The Unified Power Flow Controller (UPFC), Interline Power Flow Controllers Generalized and Multifunctional FACTS Controllers, Sub synchronous Resonance, NGH-SSR Damping Scheme, Thyristor-Controlled Braking Resistor (TCBR), Recent trends in low rating & distributed FACTS devices.

Total 45 Hours

Reference Books:

1. Understanding FACTS by Narayan G. Hingorani and Laszlo Gyugi (Standard Publishers)
2. Flexible AC Transmission System (FACTS) Edited by Yong Hua Song and Johns (IEEE Publishers)

List of e-Learning Resources:

1. <https://nptel.ac.in/courses/108107114>
2. <https://ekeeda.com/degree-courses/electrical-engineering/flexible-ac-transmission-system>

Subject Expert

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PCDEE0130A Control System

Course Objectives

This course will expose students to –

- Learn Principles and applications of control systems in every day life.
- Understand the time domain analysis of different order control system.
- Define and understand the basic criterion of stability.
- Develop the concepts about frequency domain analysis.
- Learn the designing of compensation networks.

Course Outcomes (COs)

1. Understand the concepts of open loop and closed loop control systems
2. Identify the different physical systems and determine the transfer function.
3. Design the system for different inputs and analyze time domain first and second order systems.
4. Analyze the stability criterion for time domain systems.
5. Examine the frequency response analysis of the control system.

Articulation Matrix

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CO1	2	1	1	-	-	-	-	-	-	-	-	1
CO2	1	3	2	-	-	-	-	-	-	-	-	
CO3	1	1	3	1	-	-	-	-	-	1	-	-
CO4	1	2	3	2	-	-	-	-	-	1	1	1
CO5	1	2	2	1	-	-	-	-	-	2	1	1

High-3 Medium-2 Low-1

Unit I Introduction

12 Hours

Elements of control systems, concept of open loop and closed loop systems, Examples and application of open loop and closed loop systems, brief idea of various control systems used in everyday life.

Unit II Mathematical Modeling of Physical Systems

12 Hours

Representation of physical system (Electro Mechanical) by differential equations, determination of transfer function by block diagram reduction techniques and signal flow graph method, Laplace transformation function, inverse Laplace transformation.

Unit III Time Response Analysis of First Order and Second Order System **12 Hours**

Characteristic equations, response to step, ramp and parabolic inputs. Transient response analysis, steady state errors and error constants. Brief idea of proportional, derivative and integral controllers.

Unit IV Stability and Algebraic Criteria **12 Hours**

Concept of stability and necessary conditions, Routh-Hurwitz criteria and its limitations. Root Locus technique: The root locus concepts, construction of root loci.

Unit V Frequency Response Analysis **12 Hours**

Frequency response, correlation between time and frequency responses, polar and Bode plots.

Stability in Frequency Domain: Nyquist stability criterion, assessment of relative stability: gain margin and phase margin.

Total: 60 Hours

Reference(s)

1. B. S. Manke, Linear Control System, Khanna Publisher.
2. Control Systems Theory and Applications - S. K. Bhattacharya, Pearson.
3. Control Systems - N. C. Jagan, BS Publications.
4. B. C. Kuo, Digital Control Systems, Oxford University Press, 2/e, Indian Edition, 2007.
5. K. Ogata, Discrete Time Control Systems, Prentice Hall, 2/e, 1995.

List of e-Learning Resources:

1. <https://nptel.ac.in/>
2. <https://www.coursera.org/>

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Mandsaur

Diploma - Electrical Engineering



PCDEE0140A Electric Power Transmission & Distribution

Course Objectives:

- To analyze power transmission systems and identify efficient distribution strategies for electrical networks.
- To apply principles of protection systems to safeguard electrical infrastructure against faults.
- To evaluate the performance of power transmission lines and optimize distribution networks.
- To understand the importance of relay protection schemes and their implementation in electrical grids.
- To demonstrate proficiency in designing and implementing effective protection strategies for power systems.

Course Outcomes:

1. Understand the principles of power transmission, including transmission line parameters, modeling, and power flow analysis.
2. Apply knowledge of overhead and underground transmission systems, including conductor types, mechanical characteristics, and insulator design.
3. Analyze distribution system configurations, substation layouts, and bus bar arrangements for efficient power distribution.
4. Evaluate power system protection techniques, including circuit breakers, protective relays, and differential protection schemes.
5. Demonstrate proficiency in protecting electrical equipment such as alternators, transformers, and transmission lines against faults and overvoltage's.

Articulation Matrix

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CO2	3	2	-	2	1	1	-	-	2	1	2	2
CO3	3	1	-	-	1	2	-	-	2	-	2	2
CO4	3	2	2	1	1	1	1	1	2	2	2	2
CO5	3	1	-	2	1	1	-	-	2	2	2	2

High-3 Medium-2 Low-1

Unit-I Power Transmission

9 Hours

Transmission line parameters: Resistance, inductance and capacitance of 1- Φ , 2 wire lines-composite conductors. Inductance and capacitance of 3- Φ lines. Symmetrical and unsymmetrical spacing transposition-double circuit lines-bundled conductors.

Unit-II Modeling of Transmission Lines

9 Hours

Classification of lines-short lines-voltage regulation and efficiency-medium lines-nominal T and Π configurations -ABCD constants- long lines- rigorous solution- interpretation of long line equation, ferranti effect, skin effect and proximity effect. Tuned power lines-power flow through lines-Basics only.

Unit-III Overhead Transmission

9 Hours

Conductors -types of conductors -copper, Aluminum and ACSR conductors, choice of transmission voltage. Mechanical characteristics of transmission lines – configuration-types of Towers. Calculation of sag and tension- supports at equal and unequal heights -effect of wind and ice- sag template. Insulators -different types -voltage distribution, grading and string efficiency of suspension insulators. Corona effect.

Unit-IV Underground Transmission

9 Hours

Underground cables -types of cables -insulation resistance -voltage stress -grading of cables - capacitance of single core and 3 -core cables -current rating.

Unit-V Distribution System

9 Hours

Ac single phase, 3 phase, 3wire & 4 wire distribution, Kelvin's law for most economical size of conductor substation layout showing substation equipment, bus bar single bus bar and sectionalized bus bar, main and transfer for bus bar system, sectionalized double bus bar system, ring mains.

Total 45 Hours

PRACTICAL

1. Identify intelligent, PID, Input, Output, Communication module.
2. Wire Inputs, Outputs via PLC input output modules.
3. Wire intelligent, PID, Communication module with PLC.
4. Develop ladder logic to realize all logic gates.
5. Develop ladder logic to realize multiplexer (4:1).
6. Develop ladder logic to realize demultiplexer (1:4).
7. Simulate Industrial application of PLC on Delay Timer.
8. Check the UP/DOWN counter operation using actual PLC.
9. Check the SUBTRACTION Function using actual PLC.
10. Simulate Bottle filling process on PLC simulator. Verify operation of the same process using actual PLC. Draw connection details for the same process.
11. Test the DCS.
12. Test the SCADA.
13. Set up a SCADA configuration.

Total 75 Hours

Reference Books:

1. PLCs & SCADA: Theory and Practice by Rajesh Mishra & Vikrant Vij,Laxmi Publications, New Delhi, Latest edition.
2. Computer Based Industrial Control by Krishna Kant, PHI, New Delhi, Latest edition.
3. Programmable Logic Controllers Principles and applications by Webb John W. and Reis A. Ronald, PHI, New Delhi, Latest edition.

List of e-Learning Resources:

3. <http://www.digimat.in/nptel/courses/video/108108099/L30.html>
4. www.plcsimulator.net

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Department of Electrical & Electronics Engineering

Mandsaur University

Diploma Electrical Engineering

Semester-V

L-2 T-1 P-2 C-4

PEDEE0301A Testing and Maintenance of Electrical Machines

Course Objectives

This course will expose students to –

- Understand the safety measures for various electrical equipment's.
- Understand the working and types relays and circuit breakers.
- Define basics of different types of electrical installations
- Develop the different types of earthing
- Analyze trouble shooting for various electrical equipment's and machines.

Course Outcomes (COs)

1. Understand the circuit Electrical accidents and safety measures.
2. Apply the testing and maintenance of relays and circuit breakers.
3. Classify the different Installation for various electrical equipment's.
4. Analyze the methods of Earthing for different equipment's.
5. Analyze Trouble shooting chart for various electrical equipment, machines and domestic appliances

Articulation Matrix

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CO3	2	3	1	1	-	-	-	-	-	1	1	1
CO4	3	2	2	1	1	1	-	-	-	1	1	2
CO5	2	3	2	-	-	-	-	-	-	-	-	-

High-3 Medium-2 Low-1

UNIT I Electrical Safety

9 Hours

Electrical accidents and safety measures - Electrical accidents, safety regulations, treatment of shock, fire extinguishers.

UNIT II Testing and Maintenance

9 Hours

Testing and maintenance of relays and circuit breakers - Testing of relays factory test, commissioning test and preventive periodic maintenance test. Testing of circuit breakers, voltage test, and preventive maintenance of circuit breaker. Hot line maintenance - meaning and advantages, special types of non-conducting materials used for tools for hot line maintenance.

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Diploma Electrical Engineering

UNIT III Machine installation

9 Hours

Installation - Types of heavy electrical equipment, unloading accessories precautions for unloading, installation of small and large machines of both static and rotating type. Installation of pole mounted transformer.

UNIT IV Earthing

9 Hours

Earthing-Reasons of earthing, earthing system, earth lead and its size, permissible earth resistance for different installations, improvement of earth resistance, double earthing, earth resistance measurement, rules for earthing.

UNIT V Trouble Shooting

9 Hours

Trouble Shooting -Normal performance of equipment, troubleshooting internal and external faults, instruments and accessories for trouble shooting, troubleshooting charts.

Total: 45 Hours

Reference(s)

1. B. L. Theraja Electrical Technology Vol I to IV S. Chand & Co., New Delhi.
2. B. V. S. Rao Operation & Maintenance of Electrical Machines Vol –I.
3. B. V. S. Rao Operation & Maintenance of Electrical Machines Vol.-II Media Promoters & Publisher Ltd. Mumbai.
4. C.J. Hubert Preventive Maintenance Hand Books & Journals.

List of e-Learning Resources:

5. <https://nptel.ac.in/>
6. <https://www.coursera.org/>

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Diploma: Electrical Engineering**Semester-V**

L-2 T-1 P-2 C-4

PEDEE0302A Switchgear & Protection**Course Objectives:**

This course will expose students to –

- Understand the principles and functions of electrical switchgear systems.
- Analyze various protection schemes for electrical power systems.
- Apply fault analysis techniques to diagnose electrical system issues.
- Design protection systems for power generation, transmission, and distribution.
- Evaluate the performance and reliability of switchgear and protection equipment.

Course Outcomes:

At the completion of this course, students will be able to:

1. Identify various types of faults in power system.
2. Select suitable switchgears for different applications.
3. Test the performance of different protective relays.
4. Maintain protection systems of alternators and transformers.
5. Maintain protection schemes for motors and transmission lines.

Articulation Matrix

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CO4	3	2	2	1	1	1	1	1	2	2	2	2
CO5	3	1	-	2	1	1	-	-	2	2	2	2

High-3 Medium-2 Low-1

Unit-I Basics of Protection**9 Hours**

Necessity, functions of protective system, Normal and abnormal conditions, Types of faults and their causes, Protection zones and backup protection, Short circuit fault calculations in lines fed by generators through transformers, Need of current limiting reactors and their arrangements.

Unit-II Circuit Interruption Devices**9 Hours**

Isolators- Vertical break, Horizontal break and Pantograph type, HRC fuses – Construction, working, characteristics and applications, Arc formation process, methods of arc extinction (High resistance and Low resistance), Arc voltage, Recovery voltage, Re-striking voltage, RRRV, HT circuit breakers (Sulphur-hexa Fluoride (SF₆), Vacuum circuit breaker) - Working, construction, specifications and applications, L.T. circuit breaker (Air circuit breakers (ACB), Miniature circuit breakers (MCB), Moulded, case circuit breakers (MCCB) and Earth leakage circuit breaker (ELCB)) - Working and applications. Selection of LT and HT circuit breakers (ratings), Selection of MCCB for motors. Gas insulated switchgear.

Unit-III Protective Relays**9 Hours**

Fundamental quality requirements: Selectivity, Speed, Sensitivity, Reliability, Simplicity, Economy. Basic relay terminology- Protective relay, Relay time, Pick up, Reset current, current setting, Plug setting multiplier, Time setting multiplier. Protective relays: Classification, principle of working, construction and operation of – Electromagnetic (Attracted armature type, Solenoid type, Watt-hour meter type) relay, Thermal relay. Block

Diploma: Electrical Engineering

diagram and working of Static relay. Overcurrent relay-Time current characteristics. Microprocessor based over current relays: Block diagram, working. Distance relaying- Principle, operation of Definite distance relays. Directional relay: Need and operation. Operation of current and voltage differential relay.

Unit-IV Protection of Alternator and Transformer**9 Hours****Alternator Protection**

Faults, Differential protection Over current, earth fault, overheating and field failure, protection. Reverse power protection.

Transformer Protection

Faults, Differential, over current, earth fault, over heating protection, Limitations of differential protection.

Buchholz relay: Construction, operation, merits and demerits.

Unit-V Protection of Motors, Bus-bar and Transmission Line Motor**9 Hours**

Faults, Short circuit protection, Overload protection, Single phase preventer. Bus bar and Transmission line, Faults on Bus bar and Transmission Lines., Bus bar protection: Differential and Fault bus protection., Transmission line: Over current, Distance and Pilot wire protection.

Total 45 Hours**PRACTICAL**

1. Identify various switchgears in the laboratory and write their specifications.
2. Test HRC fuse by performing the load test.
3. Test MCB by performing the load test
4. Dismantle MCCB/ELCB and identify various parts.
5. Dismantle ACB/VCB and identify different parts.
6. Set the plug and time (with PSM, TSM) of induction type electromagnetic relay.
7. Test electromagnetic over-current relay by performing load test.
8. Simulate differential protection scheme for transformer with power system simulation kit.
9. Test the working of the single phasing preventer using a three phase induction motor.
10. Simulate transmission line protection by using the impedance relay/over current relay for various faults. (On transmission line protection simulation Kit).
11. Dismantle Thyrite type arrester and identify different parts.
12. Perform neutral earthing at different substations / locations.

Total 75 Hours**Reference Books:**

1. Mehta V. K ;Rohit Mehta, Principles of Power System, S .Chand and Co., New Delhi., ISBN: 978-81-2192-496-2.
2. Rao.Sunil S., Switchgear and Protection, Khanna Publishers, New Delhi, ISBN: 978-81-7409-232-3.
3. Singh, R. P., Switchgear and Power System Protection, PHI Learning, New Delhi, ISBN: 978-81-203-3660-5.
4. Gupta. J. B.. Switchgear and Protection, S. K. Kataria and Sons, New Delhi, ISBN: 978-93-5014-372-8.

List of e-Learning Resources:

1. <http://www.digimat.in/nptel/courses/video/108108099/L30.html>

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Course Objectives

- To understand estimating and costing principles for electrical equipment, installations, and designs
- To acquire skills in cost estimation for electrical projects, considering materials, labour, and equipment
- To gain proficiency in designing and estimating wiring systems, overhead, and underground distribution lines
- To explore practical techniques for designing cost-effective substations
- To develop expertise in illumination design, considering factors influencing lighting systems

Course Outcomes (COs)

1. Remember and describe the basic principles of electrical estimation and costing
2. Understand the fundamental concepts of electrical estimation and costing
3. Apply mathematical formulas and software tools for accurate estimation
4. Analyze cost breakdowns for various electrical components and systems
5. Evaluate the effectiveness of cost-saving strategies in electrical project management

Articulation Matrix

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CO5	3	2	2	1	-	1	1	-	-	1	-	1

High-3Medium-2Low-1

Unit I Design Considerations of Electrical Installations

9 Hours

Electric Supply System, Three-phase four-wire distribution system, Protection of Electric Installation against overload, short circuit, and Earth fault, Earthing, General requirements of electrical installations, testing of installations, Indian Electricity rules, Neutral and Earth wire, Types of loads, Systems of wiring, Service connections, Service Mains, Sub-Circuits, Location of Outlets, Location of Control Switches, Location of Main Board and Distribution board, Guidelines for Installation of Fittings, Load Assessment, Permissible voltage drops and sizes of wires, estimating and costing of

Diploma Electrical Engineering

Electric installations.

Unit II Electrical Installation for Different Types of Buildings and Small Industries 9 Hours

Electrical installations for residential buildings—estimating and costing of material, Electrical installations for commercial buildings, Electrical installations for small industries.

Unit III Overhead and Underground Transmission and Distribution Lines 9 Hours

Introduction, Supports for transmission lines, Distribution lines—Materials used, Underground cables, Mechanical Design of overhead lines, Design of underground cables.

Unit IV Substations Hours 9

Introduction, Types of substations, Outdoor substation-Pole mounted type, Indoor substations-Floor mounted type

Unit V Design of Illumination Schemes Hours 9

Digital Display System and Indicators like CRT, Seven Segment LED, LED, LCD, Analog and Digital Recorders, Strip and Circular Chart Recorder, Magnetic Tape Recorder, X-Y Plotters, Ultraviolet Recorders, Digital Tape Recorders.

Total: 45 Hours

References:

1. Electrical Design Estimating and Costing (2006) ,K.B.Raina, S.K.Bhatt Acharya ,New Age International Publisher.
2. Design of Electrical Installations (2009),Er.V.K.Jam, Er. Amitabh Bajaj, University Science Press.

Subject Expert

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Diploma Electrical Engineering

