ST. VINCENT PALLOTTI COLLEGE OF ENGINEERING & TECHNOLOGY, NAGPUR

(An autonomous institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

B. Tech. Scheme of Examination & Syllabus 2021-22

ELECTRICAL ENGINEERING

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE701T	Switchgear and Protection	3			3	30	70	100

Course Objectives	Course Outcomes
This course is intended to realize the importance of power system protection. understand different types of Relays and Protective Schemes used in power system protection. introduce construction, working and applications of Circuit Breakers.	**Students will be able to** explain basic terminology of Protective Relaying. describe over-current protection schemes for transmission lines. explain various distance protection schemes for transmission lines. explain different protections used for Generator, Transformer and Motors. describe working of circuit breakers.

Unit I	**[7Hrs]**
General Philosophy of Protection: - Necessity of protection, Nature and causes of faults, Types and effects of faults, Fault Statistics, Protective zones, Primary and Back-up protection, Essential qualities of Protection, Basic trip circuit. Classification of relays. Introduction of Electromechanical, Static and Numerical relays.	
Unit II	**[7Hrs]**
Over-current Protection: - Time-Current characteristics, Current setting, Time setting, Relay coordination, Over current protection schemes for transmission Lines, directional-over current relay, Protection of parallel feeders and ring mains.	
Unit III	**[8Hrs]**
Distance Protection: - Working principle and characteristic of Impedance Relay, Mho Relay, Reactance Relay, Three step distance protection scheme for transmission Lines, Effect of arc resistance on the operation of distance relays. Carrier current protection.	
Unit IV	**[7Hrs]**
Equipment Protection: - Principle of differential relaying, causes and remedies for mal operation of differential protection, protection of generator and transformer by differential relaying and other relays. Protection of Induction Motors against overloading and short circuits.	
Unit V	**[7Hrs]**
Switchgears: - Arc interruption theory, Recovery and Restriking voltage, RRRV, different medium of arc interruption, Construction and operation of SF_6 and vacuum circuit breakers, rating of circuit breaker.	

Text Books

S.N	Title	Authors	Edition	Publisher
1	Switchgear and Protection	Sunil S. Rao	Latest	Khanna publication
2	Power system protection and Switchgear	B Ram, D Vishwakarma	Latest	Tata McGraw Hill
3	Fundamental of power system protection	Y. Paithankar, S. Bhide	Latest	Prentice hall

Reference Books

S.N	Title	Authors	Edition	Publisher
1	The art and science of protective relaying	C. Russell Mason	Latest	Willey
2	Protective Relaying Vol. I & II	Warrington	Latest	Springer
3	Switchgear Handbook	R. T. Lythall	Latest	Butterworth, London

		JULY 2024	1	Applicable for 2024-25
Chairman - BoS	Dean – Academics	Date of Release	Version	

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE701P	Switchgear and Protection Lab			2	1	25	25	50

Course Objectives	Course Outcomes
This course is intended to realize the importance of power system protection. understand different types of Relays and Protective Schemes used in power system protection. introduce construction, working and applications of Circuit Breakers.	**Students will be able to** plot the characteristics of MCB. plot the magnetic characteristics of current transformer. use Electromechanical and Static relays. use over-voltage and over-current relay. use numerical relay.

Minimum 08 experiments to be conducted based on the syllabus. List of experiments may get modified.

Sr. No. (Any 08)	Title of the experiment (Any 08)
1	To plot the characteristic of MCB.
2	To plot the magnetization characteristic of current transformer.
3	To study the behaviour of static over voltage relay.
4	To plot the characteristic of static IDMT over current relay.
5	To plot the characteristic of numerical over current relay.
6	To study the operation of Buchholz relay.
7	To study the behaviour of electromagnetic under voltage relay.
8	To study the behaviour of electromagnetic over current relay.
9	To study the behaviour of reverse power relay.
10	Study of various relays.

Text Books

S.N	Title	Authors	Edition	Publisher
1	Switchgear and Protection	Sunil S. Rao	Latest	Khanna publication
2	Power system protection and Switchgear	B Ram, D Vishwakarma	Latest	Tata McGraw Hill
3	Fundamental of power system protection	Y Paithankar, S Bhide	Latest	Prentice hall

Reference Books

S.N	Title	Authors	Edition	Publisher
1	The art and science of protective relaying	C. Russell Mason	Latest	Willey
2	Protective Relaying Vol. I & II	Warrington	Latest	Springer
3	Switchgear Handbook	R. T. Lythall	Latest	Butterworth, London

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE702P	Power System Simulation Lab			2	1	25	25	50

Course Objectives	Course Outcomes
This course is intended ● To learn the concept of MATLAB, LABVIEW and PSIM Software's and apply it in the field of engineering and technology especially electrical power system simulation ● To apply programming and simulation knowledge to solve and design programs for applications related to electrical engineering	**Students will be able to** ● To analyze MATLAB , PSIM and LABVIEW Software toolboxes ● To develop and design programs in MATLAB Simulink ● To evaluate power system models in MATLAB, PSIM and LABVIEW Software

Expt. No. (Any 08)	Title of the experiment (Any 08)
1	To Determine Efficiency and Regulation of a medium transmission line by forming symmetric T network using MATLAB Software
2	Formation of Z Bus (without mutual coupling) using Z-Bus Building Algorithm using MATLAB Software
3	To Simulate and Design Suspension Insulator in MATLAB Software
4	To write a program in MATLAB for Bus Incidence Matrix
5	To Simulate Power System Protection using LABVIEW Software
6	To Simulate and Design rectifier circuit in PSIM Software
7	To simulate Inverter Circuit in PSIM Software
8	To study fault scenario in Power System using Virtual Lab IIT Bombay
9	To write a program in MATLAB for Ferrantii Effect

Text Books

S.N	Title	Authors	Edition	Publisher
1	Getting started with MATLAB	Rudra Pratap	2	Oxford
2	MATLAB and Simulink	Agam Tyagi	1	Oxford

Reference Books

S.N	Title	Authors	Edition	Publisher
1	MATLAB for Engineers	William J Palm	1	Tata Mcgraw Hill

Chairman - BoS	Dean – Academics	JULY 2024 Date of Release	1 Version	Applicable for 2024-25

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B. Tech. Scheme of Examination & Syllabus AY: 2021-22

ELECTRICAL ENGINEERING

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE703T	Electrical Installation Design	4		-	4	30	70	100

Course Objectives	Course Outcomes
• To learn methodology of electrical loads, types of electric loads & selection of busbar and cables • To study switching and protection devices along with short circuit calculations • To study Power and control circuit for industrial application utilizing Reactive power Management • To learn industrial installations and earthling system design • To study design of substations used for industrial installations	**Students will be able to** • Understand concept of electrical load assessment and basics of busbar and cables • Identify switches for smooth functioning of protective scheme utilized for short circuit calculations • Analyze Power and control circuit for industrial application utilizing Reactive power Management • Apply industrial installations and earthling system design • Inferring the design of 11kV and 33 kV substations for industrial installations

Unit I **[12 Hrs]**

(A): ELECTRICAL LOAD ASSESSMENT:

Categories of load, types of loads, connected load, demand factor, Maximum demand, diversity factor, load factor, power factor,

(B): CABLES, CONDUCTORS & BUS- BARS:

Construction, selection, installation, overload & short circuit ratings, rating factors; Overhead line conductors.

Unit II **[10 Hrs]**

(A): SWITCHING & PROTECTION DEVICES:

Types, specifications; selections of isolators, switches, switch fuse units, MCB, ELCB, MCCB, ACB, VCB, SF6 breakers

(B): SYMMETRICAL SHORT CIRCUIT CALCULATIONS:

Determining symmetrical short circuit currents at various locations for selecting proper circuit breaker rating & determining value of series reactors for limiting short circuit current.

Unit III **[10 Hrs]**

(A): ELECTRIC SUPPLY TO INDUCTION MOTORS IN INDUSTRIES:

Types of motors, SLD and working of DOL/ Star-Delta/ Autotransformer starters; types, specifications.

(B): REACTIVE POWER MANAGEMENT IN INDUSTRIES:

Reactive power compensation in industries using static capacitors, use of Power Triangle, Calculating payback period for capacitor investment due to reduced system currents.

Unit IV **[08Hrs]**

DESIGN OF INDUSTRIAL ELECTRICAL INSTALLATION:

Preparing load list, assessing various factors associated with loads, selection of transformer, busbars, cables, switchgear, protective devices, earthling system, testing, commissioning.

Unit V **[08 Hrs]**

SUBSTATIONS:

- 11kV & 33kV, indoor/ outdoor substations, plan/ elevations, Solar Roof Top Installation Design
- IE Rules applicable to residential, commercial & industrial installations

Text Books

S. N.	Title	Authors	Edition	Publisher
1	A Text Book of Design of Electrical Installations	V. K. Jain, Amitabh Bajaj		Laxmi Publications
2	Principles of Power Systems	V. K. Mehta		S. Chand Publication
3	Utilization of Electric Power & Electric Traction	J. B. Gupta		Kataria Publications

Reference Books

S. N.	Title	Authors	Edition	Publisher
1	Indian Electricity Rules 1956		Latest	
2	IS 3043, Code of Practice for Earthing		Latest	
3	Residential, Commercial and Industrial Electrical Systems, Volume 1, 2, 3	Hemant Joshi		TMGH Publications

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ELECTRICAL ENGINEERING

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE704T(i)	PE-IV:Power Semiconductor Based Drives	3			3	30	70	100

Course Objectives	Course Outcomes
This course is intended ● To introduce with the operation and performance of dc and ac drives ● To make understand various control techniques used in control of the machines ● To familiarize with the traction drives using ac and dc motors.	**Students will be able to** ● Understand dynamics of electric drives used in industry with steady state stability. ● Apply the knowledge of various converters control methods used for DC drives. ● Analyze control typologies used for induction motor applicable to various industrial Applications. ● Select synchronous motor and advanced motor drives used for special applications. ● Understand the traction drives using ac and dc motors with advanced control.

Unit I	**[6Hrs]**
Dynamics of Electric Drives: Power Modulators, Four Quadrant Operation,Components of Load torque, Fundamental torque equation, Control of Electric Drives, Modes of operation,Speed transition. Steady state stability of Drive.Energy Conservation in Electrical Drives.	
Unit II	**[8Hrs]**
D.C.Motor Drives :- Introduction of D.C.Motor drives, controlled rectifier fed D.C. Drives, single phase and three phase rectifier control of D.C. separately excited motor. Dual converter control of D.C. separately excited motor. Power factor supply harmonics and ripple in motor current. Chopper controlled DC drives of separately excited DC motor chopper control of series motor, source current harmonics.	
Unit III	**[8Hrs]**
Induction Motor Drives : Introduction of Induction motor drives, stator voltage control, variable frequency control using voltage source inverter, current source inverter & cycloconverter.	
Unit IV	**[8Hrs]**
Synchronous Motor Drives and Advanced Motor Drives : Introduction of Synchronous Motor Drives, starting, braking of synchronous motor, variable frequency control, self-controlled synchronous motor drive employing load commuted thyristor inverter or cycloconverter, starting of large synchronous motors. Brushless dc motor(BLDC) drives, Stepper Motors, Switched Reluctance Motor, Solar and battery powered drives	
Unit V	**[6Hrs]**
Traction Drives : Conventional D.C. and A.C. traction drives, semiconductors converter controlled Drives, 25KV AC Traction using semiconductor converter controlled DC Motor. DC Traction using semiconductor, chopper controlled DC motors	

Text Books

S.N	Title	Authors	Edition	Publisher
1	Fundamentals of Electrical Drives	G. K. Dubey	2nd	Narosa
2	Modern Electric Traction	H. Partab	2nd	Dhanpat Rai
3	Electric Drives	Vedam Subhramanyam	2nd	McGraw-Hill

Reference Books

S.N	Title	Authors	Edition	Publisher
1	Electrical Drives Control	R Krishnan	2nd	PHI
2	Modern Power Electronics and AC Drives	B.K.Bose	2nd	PHI

		JULY 2024	1	Applicable for 2024-25
Chairman - BoS	Dean – Academics	Date of Release	Version	

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE704T(ii)	PE-IV: Flexible AC Transmission System	3			3	30	70	100

Course Objectives	Course Outcomes
This course is intended to ● understand the Problems and Constraints related with Stability and Large Interconnected System. ● familiarize students with Voltage Source Converters, Current Source Converters and Harmonic Elimination technique. ● Study different types of FACTS Controllers for the solution of Problems and Constraints related with Stability and Large Interconnected System ● study Shunt and Series, FACTS Controllers ● study Static Voltage Regulators ,Phase angle Regulators and Combined Compensators	After Successful Completion of this course students will be able to demonstrate the ability to have: ● Knowledge of Power Flow in AC system with different factors affecting stability ● Knowledge of Voltage and Current Source Converters ● Knowledge of Static Shunt Compensators ● Knowledge of Static Series Compensators ● Knowledge of Static Voltage and Phase angle Regulators and Basic Concept of Combined Compensators

Unit I	**[08Hrs]**
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, relative importance of controllable Parameters, FACTS Controller.	
Unit II	**[08Hrs]**
Unit-II: VOLTAGE-SOURCE AND CURRENT. SOURCE CONVERTERS: Single phase three phase full wave bridge converters transformer connections for 12 pulse operation. Threelevel voltage source converter, Generalized Technique of Harmonic Elimination and Voltage Control, basic concept of current source Converters,and comparison of current source converters with voltage Source Converters.	
Unit III	**[08Hrs]**
Unit-III: STATIC SHUNTS COMPENSATORS: SVC AND STATCOM: Objectives of shunt Compensation, midpoint voltage regulation voltage instability prevention, improvement of transient stability, Methods of Controllable VAR Generation, Static Var Compensators SVC and STATCOM, Comparison Between SVC and STATCOM	
Unit IV	**[06Hrs]**
Unit-IV: STATIC SERIES COMPENSATORS: GCS, TSSC, TCSC AND SSSC: Objectives of series Compensation, improvement of transient stability, Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators (only SSSC).	
Unit V	**[06Hrs]**
Unit-V: STATIC VOLTAGE AND PHASE ANGLE REGULATORS; TCVR AND TCPAR, UPFC and IPFC: Objectives of Voltage and Phase Angle regulators, Approaches to Thyristor Controlled Voltage and Phase Angle Regulators (TCVR and TCPARs), Introduction and Operating principle of Unified Power Flow Controller (UPFC) and Interline Power Flow Controllers of UPFC and IPFC	

Text Books

S. N.	Title	Authors	Edition	Publisher
1	Understanding FACTS	Narayan G. Hingorani and Laszlo Gyigyi	Third	Standard Publishers
2	FACTS : Controllers in Power Transmission & Distribution	K. R. Padiyar	First	New Age International

Reference Books

S. N.	Title	Authors	Edition	Publisher
1	HVDC and FACTS Controller Application of Static Converters in Power System	V. K. Sood	Third	New Age International Private Limited

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ELECTRICAL ENGINEERING

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE704T(iii)	PE-IV: Advanced Control Systems	3			3	30	70	100

Course Objectives	Course Outcomes
This course is intended ● To study state variable approach and feedback design problems and also concept of Optimal Control theory. ● To learn basics of digital control system, its representation in state space model and stability investigation. ● Impart the knowledge of different non-linearities present in physical system and its stability analysis.	**Students will be able to** ● Determine State Transition Matrix and solution of state equation for the given system. ● Evaluate controllability, observability and design suitable state feedback vector for the given control system. ● Evaluate Optimal Control Problem using Integral Square Error. ● Analyze nonlinear system using the describing function technique ● Solve stability problems of discrete time digital control system.

Unit I	**[6Hrs]**
State Variable Analysis: Review of state variable representations ,diagonalization of state model ,eigen value, eigen vectors and stability , generalized eigen vector, properties of state transition matrix (STM) ,Computation of STM by Laplace transform, Cayley Hamilton theorem and Canonical transformation method. Solution of state equation	
Unit II	**[6Hrs]**
Control System Design in State Space: Concept of Controllability & Observability. Kalman's test and Gilbert's test, Duality, Effect of Pole Zero cancellation on Controllability and Observability.Design of State variable feedback. Pole Placement design through effect of state feedback	
Unit III	**[8Hrs]**
Optimal Control System: Performance Index (PI). Desirability of single P.I.Integral Square Error (ISE), Parseval's Theorem, parameter Optimization with &without constraints.	
Unit IV	**[6Hrs]**
Non Linear Control Systems: Types of non – linearities, jump resonance.Describing function analysis and its assumptions. Describing function of some common non- linearities. Singular points. Stability from nature of singular points. Limit cycles.	
Unit V	**[6Hrs]**
Digital Control System: Basics of Digital Control System, Representation of Sampled Data Control System. Sample & Hold circuit. Effects of Sampling,Shannon's Sampling theorem. Z- Transform, Inverse Z- Transform solution of Differential Equations. domain relationship. Stability by Bi- linear transformation .	

Text Books

S.N	Title	Authors	Edition	Publisher
1	Control Systems- Principles and Design:	M. Gopal	3rd	McGraw Hill Education
2	Control Systems Engineering	Nagrath & Gopal	2nd	New Age International
3	Digital Control Engineering	M. Gopal	2nd	Wiley Eastern

Reference Books

S.N	Title	Authors	Edition	Publisher
1	Modern Control Engineering	K. Ogata	2nd	Prentice Hall
2	Digital Control and State Variable Methods	M. Gopal	2nd	McGraw Hill Education

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ELECTRICAL ENGINEERING

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE704T(iv)	PE-IV:Energy Management and Audit	3	-	-	3	30	70	100

Course Objectives	Course Outcomes
This course is intended to ● To understand the need of energy audit and the mechanism through which it should be carry out. ● To manage the Electrical and Thermal energy.	Students will be able to ● Identify the demand supply gap of energy in Indian scenario. ● Carry out energy audit of an industry/Organization. ● Draw the energy flow diagram of an industry and identify the energy wasted or a waste. ● Deal with Energy Monitoring and Targeting System. ● Select appropriate energy conservation method to reduce the wastage of energy in Electrical & Thermal utilities.

Unit I	[08Hrs]
Basics of Energy Management and Conservation: Global and Indian energy scenario, Global environmental concerns, Climate Change, Concept of Energy Management, Energy demand and supply, economic analysis; Carbon Trading & Carbon foot prints. Energy Conservation: Basic concepts, Energy conservation in household, transportation, agricultural, service and industrial sectors; Lighting & HVAC systems in buildings.	
Unit II	[07Hrs]
Energy Audit: Definition, Need and types of energy audit; Energy management (audit) approach: Understanding energy costs, bench marking, energy performance; Energy audit instruments; Highlights of Energy Conservation Act.	
Unit III	[07Hrs]
Material & Energy balance and Waste Heat Recovery Facility as an energy system; Methods for preparing process flow; material and energy balance diagrams. Co-generation and waste heat recovery	
Unit IV	[07Hrs]
Energy Action Planning, Monitoring and Targeting: Energy Action Planning : Key elements; Force field analysis; Energy policy; Roles and responsibilities of energy managers and auditors. Monitoring and Targeting : Defining monitoring & targeting; Elements of monitoring & targeting; Managerial Functions in Monitoring & Targeting.	
Unit V	[07Hrs]
Electrical & Thermal Energy Management: Energy Management: Supply side: Methods to minimize supply-demand gap, reactive power management, Demand side management: Energy conservation in electric motors, Thermal Energy Management: Energy conservation in boilers, Steam turbines and Furnaces	

Text Books

S. N	Title	Authors	Edition	Publisher
1	Handbook on Energy Audits and Management	Amit Kumar Tyagi		TERI
2	Wayne C. Turner	Wayne C. Turner		Wiley Inter Science Publication

Reference Books

S. N	Title	Authors	link
1	Guide book for National Certification Examination, BEE	Bureau of Energy Efficiency	https://aipnpc.org/Guidebooks.aspx

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ELECTRICAL ENGINEERING

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE704T(v)	PE-IV: Electrical Distribution System	3			3	30	70	100

Course Objectives	Course Outcomes
• To know about practical electrical distribution system and its necessity in the real world. • The conceptual knowledge on how to determine the performance of a distribution system through its important parameters i.e voltage drops and power losses. • How to improve the voltage profiles and power factor of the system to better value using various voltage control and compensation techniques.	**Students will be able to** • Explain the general aspects of electrical distribution system • Design and analysis of distribution feeders and substations • Calculate the voltage drop and power loss in the distribution system • Analyze the need for protection and distribution automation. • Evaluate the PF, Voltage and Power and design the equipment used to control it.

Unit I	**[6 Hrs]**
INTRODUCTION & GENERAL CONCEPTS: Introduction to distribution systems, Load modeling and characteristics. Coincidence factor, contribution factor loss factor - Relationship between the load factor and loss factor. Classification of loads: Residential, commercial, Agricultural and Industrial loads and their characteristics.	
Unit II	**[7 Hrs]**
DISTRIBUTION FEEDERS & SUBSTATIONS: Design Considerations of Distribution Feeders: Radial and loop types of primary feeders, voltage levels, feeder loading; basic design practice of the secondary distribution system. SUBSTATIONS: Rating of distribution substation, service area within primary feeders, Benefits derived through optimal location of substations, Layout of the Substation	
Unit III	**[8 Hrs]**
DISTRIBUTION SYSTEM ANALYSIS: Voltage drop and power-loss calculations: Derivation for voltage drop and power loss in lines, manual methods of solution for radial networks, three phase balanced primary lines.	
Unit IV	**[7 Hrs]**
PROTECTIVE DEVICES&AUTOMATION : Objectives of distribution system protection, types of common faults and procedure for fault calculations. Protective Devices: Principle of operation of Fuses, Circuit Reclosures and line sectionalizes, and circuit breakers. Automation:-Introduction to distribution automation, Data Acquisition System and decentralized control, data acquisition and protection considerations of control panel.	
Unit V	**[8 Hrs]**
VOLTAGE CONTROL & POWER FACTOR IMPROVEMENT: Equipment for voltage control, effect of series capacitors, line drop Compensation, effect of AVB/AVR, Power factor control using different types of power capacitors, shunt and series Capacitors, effect of shunt capacitors (Fixed and Switched), capacitor allocation- Economic Justification- Procedure to determine the best capacitor location.	

Text Books

S.N	Title	Authors	Edition	Publisher
1	Electrical Power Distribution Systems	V. Kamaraju		Tata Mc Graw-Hill Publishing Company
2	Electrical Power Distribution Systems	A. S. Pabla		Tata Mc Graw-Hill Publishing Company
3	Electric Power Distribution Automation	M. K. Khedkar& G. M. Dhole		University Science Press

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ELECTRICAL ENGINEERING

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE704T(vi)	PE-IV: HVDC Transmission System	3			3	30	70	100

Course Objectives	Course Outcomes
1. To enable an overview of basic concepts HVDC transmisson systems and components 2. To enable understanding of power flow control methods, filtering requirements and converter protection scheme.	Students will be able to • Compare AC and DC transmission technologies. • Analyze the operation of converters and inverters. • Identify various control methods of HVDC system. • Design the filters for eliminating the harmonics. • Analyze effect of operating HVDC link in parallel to AC and identify various types of MTDC link

Unit I	**[7Hrs]**
Comparison of EHVAC and HVDC systems, Kinds of DC link, Earth Electrode and earth-returns : Introduction & objectives ,location and configuration, Multi terminal HVDC system: Introduction, 2pole transmission, MTDC system with series and parallel connected converters..	
Unit II	**[7Hrs]**
Line Commutated Converters (LCCs): Six pulse converter, Inverter Operation. Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter. Equations in the rotating frame. Real and Reactive power control using a VSC, SVC and STATCOM	
Unit III	**[8Hrs]**
Power flow control in HVDC system: Constant current. Constant voltage, constant ignition and excitation angle control, control characteristics. Parallel operation of AC and DC links (Synchronous and Asynchronous links).	
Unit IV	**[7Hrs]**
Harmonic Filters: Types of Filter, Configuration of AC filters, design of AC filters, single & double frequency tuned filters, Configuration of D.C. Harmonic filters, Grouping of AC & DC filters, Reactive power compensation: Reactive power requirements of HVDC convertors, effect of Delay angle and extinction angle on reactive power.	
Unit V	**[7Hrs]**
HVDC circuit breakers Introduction, construction, principle, switching energy interruption of DC current application of MRTB, types of HVDC C.B., HVDC substation protection against short-circuit: fault Clearing, protective zones, protection symbols, HVDC line pole protections(fault clearing and reenergizing), HVDC sub-station protection against over voltage between Insulation coordination of AC and DC systems, surge-Arrestors protection scheme .Insulation coordination and protection margin.	

Text Books

S.N	Title	Authors	Edition	Publisher
1	EHVAC and HVDC Transmission Engineering and practice.	Sunil S. Rao		Khanna publications
2	Electrical Power Systems	C.L.Wadhwa		New Age International

Reference Books

S.N	Title	Authors	Edition	Publisher
1	HVAC Transmission	Rakosh Das Begamudre		New Age International

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ELECTRICAL ENGINEERING

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE761O(i)	OE-III: Power Plant Engineering	3			3	30	70	100

Course Objectives	Course Outcomes
• To provide an overview of various types of power plants. • To provide issues associated with energy conversion.	**Students will be able to understand** • Electrical energy, economic and environmental issues. • Operation of Thermal power Plant. • Subsystems of thermal power plants and cogeneration systems. • Operation of Hydroelectric Power Plants. • Operation of Nuclear Energy Conversion.

Unit I	**[6 Hrs]**
Energy, Economic and Environmental Issues: Power tariffs, load distribution parameters, load curve. Pollution control technologies including waste disposal options for coal and nuclear plants.	
Unit II	**[7 Hrs]**
Coal Based Thermal Power Plants: Basic Rankine cycle and its modifications, layout of modern coal power plant, boilers, turbines, condensers, steam and heating rates.	
Unit III	**[8 Hrs]**
Subsystems of thermal power plants: Fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems.	
Unit IV	**[7 Hrs]**
Hydroelectric Power Plants: Classification, typical layout and various components.	
Unit V	**[8 Hrs]**
Basics of Nuclear Energy Conversion: Layout and subsystems of nuclear power plants, gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.	

Text Books

S.N	Title	Authors	Edition	Publisher
1	Power Plant Engineering	P. K. Nag	3rd	Tata Mc Graw-Hill Publishing Company
2	Power Plant Technology	El Wakil M. M.		Tata Mc Graw-Hill Publishing Company
3	Power Plant Engineering	Eliot T. C. , Chen K.	2nd	Tata Mc Graw-Hill Publishing Company

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE761O(ii)	OE-III: Power Electronics	3			3	30	70	100

Course Objectives	Course Outcomes
This course is intended to ● introduce students, the basic theory of power semiconductor devices and their practical application in power electronics ● familiarize the operation principle of AC-DC, AC-AC, DC- DC, DC-AC conversion circuits and their applications ● provide the basis for further study of power electronics circuits and systems.	A student who successfully fulfil the course requirements will be able to ● understand basic operation of SCR and basic principle of switching circuits ● understand basic operation of various power semiconductor devices, along with their applications in electrical circuits. ● understand basic operation and characteristics of various power semiconductor devices ● understand the concepts of AC to DC and AC to AC circuit ● understand the concepts of DC to AC and DC to DC circuit

Unit I	**[08Hrs]**
SCR : V-I, turn on & turn off characteristics, rating, gate characteristics, over voltage and over current protection, Snubber circuit. Commutation techniques of SCR.	
Unit II	**[08Hrs]**
Static controllable switches I : Characteristics & working of TRIAC, DIAC, UJT, AC regulator and working principle of UJT as relaxation oscillator	
Unit III	**[08Hrs]**
Static controllable switches II: Characteristics & working of MOSFET, Gate turn off thyristor and Insulated gate bipolar transistor.	
Unit IV	**[06Hrs]**
Phase controlled Rectifiers (AC-DC Converters) : Single phase half Wave controlled, full wave controlled rectifiers with R and RL load, Bridge Configurations with R and RL load, Effect of Freewheeling diode. **AC-AC Converters** • Basic Principle, Operation, Single phase AC voltage controller for R and RL loads.	
Unit V	**[06Hrs]**
DC-DC converters (Chopper) Working principle of chopper, Types of chopper : Step-Up & Step-Down chopper for RL Load, Class-A, class-B, Class-C, Class-D and Class-E chopper, Control Strategies. **DC-AC Converters (Inverter)** Classification of inverter, Working Principle of single phase Half Bridge and Single Phase Full Bridge inverter for R and RL load.	

Text Books

S. N.	Title	Authors	Edition	Publisher
1	Power Electronics Circuits Devices and Applications	M. H. Rashid	Third	Pearson
2	Power Electronics	M. D. Singh & K. B. Khanchandani	Second	Tata McGraw Hill
3	Power Electronics	P. C. Sen.	Second	Tata McGraw Hill

Reference Books

S. N.	Title	Authors	Edition	Publisher
1	Power Electronics : Converters, Applications, and Design	Ned Mohan, Tore M. Undeland, William P. Robbins	Third	John Wiley & Sons

		July 2024	1	Applicable for 2024-25
Chairman - BoS	Dean – Academics	Date of Release	Version	

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE705P	Project II			6	3	75	75	150

Course Objectives	Course Outcomes
This course is intended • To enable the Students to undertake short research projects and fabricate it.	**Students will be able to** • explain fabrication work of project set up / devices or developed software.

S.N.	Project
1	**Projects are based on :** Recent Trends in Electrical Power System, Power Electronics and Renewable Energy.

SEVENTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE705P	Project II			6	3	75	75	150

Course Objectives	Course Outcomes
This course is intended • To enable the Students to undertake short research projects and fabricate it.	**Students will be able to** • explain fabrication work of project set up / devices or developed software.

S.N.	Project
1	**Projects are based on :** Recent Trends in Electrical Power System, Power Electronics and Renewable Energy.

SIXTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE707P	Capstone Course II			2	1	50	-	50

Course Objectives	Course Outcomes
This course is intended • To revise and test comprehensive knowledge gained in Electrical Engineering branch by the students	**Students will be able to** • Prepare for technical entrance exam for pursuing higher studies (Like GATE , MH CET for M.Tech) • Prepare for technical entrance exam required to be employed in Government like (IES , MPSC & UPSC)

S.N.	Capstone Course-II
1	**Preparation of objective questions based on :** Recent Trends in Electrical Power System, Power Electronics and Renewable Energy , emerging technologies , and multidisciplinary areas..

SIXTH SEMESTER

Course Code	Course Name	Th	Tu	Pr	Credits	Evaluation		
						CA	ESE	Total
21EE707P	Capstone Course II			2	1	50	-	50

Course Objectives	Course Outcomes
This course is intended • To revise and test comprehensive knowledge gained in Electrical Engineering branch by the students	**Students will be able to** • Prepare for technical entrance exam for pursuing higher studies (Like GATE , MH CET for M.Tech) • Prepare for technical entrance exam required to be employed in Government like (IES , MPSC & UPSC)

S.N.	Capstone Course-II
1	**Preparation of objective questions based on :** Recent Trends in Electrical Power System, Power Electronics and Renewable Energy , emerging technologies , and multidisciplinary areas..