

ACADEMIC REGULATIONS COURSE STRUCTURE AND DETAILED SYLLABUS

**ELECTRICAL AND ELECTRONICS
ENGINEERING**

for

M.Tech. – High Voltage Engineering
(Applicable from 2025-2026 Batches)



UNIVERSITY COLLEGE OF ENGINEERING KAKINADA (*Autonomous*)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

KAKINADA - 533 003, ANDHRA PRADESH, INDIA

Vision and Mission of the Institute

Vision:

To be a premier institute of excellence developing highly talented holistic human capital that contributes to the nation through leadership in technology and innovation through engineering education.

Mission:

1. To impart Personnel Skills and Ethical Values for Sustainable Development of the Nation.
2. To create Research & Industry oriented centers of excellence in all engineering disciplines.
3. To be a renowned IPR generator and repository for innovative technologies.
4. To develop Research and Industry oriented technical talent.
5. To benchmark globally the academic & research output.

Vision and Mission of the Department

Vision:

To be in the forefront in advanced research in emerging areas of Electrical & Electronics Engineering, be proactive with industry in technology development and moulding the department into a center of academic excellence.

Mission:

1. To produce high quality Electrical and Electronics Engineering graduates with the requisite theoretical and practical knowledge.
2. To undertake research & development and extension activities in the field of Electrical and Electronics Engineering in the area of relevance for immediate application as well as for establishing and strengthening the fundamental knowledge.
3. To create social awareness and ethical values in the graduates so as to contribute in the progress of the society.

Program Education Objectives (PEOs)

PEO1:	Students will develop and apply advanced knowledge and technical skills in high voltage engineering to analyze, design, and maintain high voltage systems used in power transmission and industrial applications.
PEO2:	Students will be equipped to engage in research, innovation, and application of emerging technologies to solve complex engineering problems, contributing to advancements in high voltage engineering and industry growth.
PEO3:	Students will cultivate professionalism, ethical values, and a mindset of lifelong learning, enabling them to contribute effectively to society and sustainable development in the energy and power sectors.

Mapping of PEOs with Mission of the department

	PEO1	PEO2	PEO3
M1	S	M	W
M2	M	S	W
M3	W	M	S

(Rubrics: S = Strongly related M = Moderately related W = Weakly related)

Program Outcomes (POs)

PO1:	An ability to independently carry out research /investigation and development work to solve practical problems
PO2:	An ability to write and present a substantial technical report/document
PO3:	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO4:	An ability to design, analyze, test, and diagnose high voltage insulation systems and apparatus while adhering to professional and ethical standards to ensure safety and reliability.
PO5:	An ability to apply modern simulation, modeling, and optimization techniques for analysis and improvement of high voltage and power systems with consideration for sustainable and ethical engineering practices.

Mapping of POs with PEOs:

Program Outcomes (PO's)	Program Education Objectives (PEOs)		
	PEO1	PEO2	PEO3
PO1	M	S	W
PO2	W	M	S
PO3	S	M	M
PO4	S	M	M
PO5	S	S	M

(Rubrics: S = Strongly related M = Moderately related W = Weakly related)

COURSE STRUCTURE**I – Semester**

S. No.	Course Code	Course Title	L	T	P	C
1		Program Core – 1 Generation and Measurement of High Voltages	4	0	0	4
2		Program Core – 2 Dielectrics and Insulation Engineering	4	0	0	4
3		Program Core – 3 HVDC Transmission	4	0	0	4
4		Program Elective – 1	3	0	0	3
5		Program Elective – 2	3	0	0	3
6		Laboratory – 1: High Voltage Laboratory	0	0	4	2
7		Laboratory – 2 : HV Simulation Laboratory – I	0	0	4	2
8		Technical Seminar-I	0	0	2	1
		TOTAL	15	5	6	23

Program Elective – 1 & 2

- i. AI Applications in High Voltage
- ii. Energy Auditing, Conservation and Management
- iii. Electric Vehicles.
- iv. High Voltage Power Transformers and Diagnostics
- v. Smart Grids
- vi. Advanced Electrical Insulation Systems

II – Semester

S. No.	Course Code	Course Title	L	T	P	C
1		Program Core – 4 High Voltage Testing Techniques	4	0	0	4
2		Program Core – 5 Surge Phenomenon & Insulation Coordination	4	0	0	4
3		Program Core – 6 EHVAC Transmission	4	0	0	4
4		Program Elective – 3	3	0	0	3
5		Program Elective – 4	3	0	0	3
6		Laboratory – 3: Advanced High Voltage Laboratory	0	0	4	2
7		Laboratory – 4: HV Simulation Laboratory – II	0	0	4	2
8		Technical Seminar – II	0	0	2	1
		TOTAL	15	5	6	23

Program Elective – 3 & 4

- i. Partial Discharge in HV Equipment
- ii. Condition Monitoring of high voltage Power Equipment
- iii. Outdoor High Voltage Insulators
- iv. FACTS Controllers
- v. Renewable Energy Technologies
- vi. Nano Dielectrics

III – Semester

S. No.	Course Code	Course Title	L	T	P	C
1		Research Methodology and IPR / <i>Swayam 12 week MOOC course – RM&IPR</i>	3	0	0	3
2		Summer Internship/ Industrial Training (8-10 weeks)*	-	-	-	3
3		Comprehensive Viva [#]	-	-	-	2
4		Dissertation Part – A ^{\$}	-	-	20	10
		TOTAL	3	-	20	18

* Student attended during summer / year break and assessment will be done in 3rd Sem.

Comprehensive viva can be conducted courses completed upto second sem.

\$ Dissertation – Part A, internal assessment

IV – Semester

Sl. No.	Course Code	Course Title	L	T	P	C
1		Dissertation Part – B [%]	-	-	32	16
		TOTAL	-	-	32	16

% External Assessment

M.Tech. I-Semester

COURSE CODE –	GENERATION & MEASUREMENT OF HIGH VOLTAGES (Program Core-1)	CATEGORY PC	L-T-P 4-0-0	CREDITS 4
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Pre-requisite: Basic Electrical Engineering / Electrical Machines, Power Systems, Electrical Measurements and Instrumentation, Circuit Theory.

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

		Knowledge Level (K)#	Related Units
CO1	Analyze the principles and methods of generating high AC, DC, and impulse voltages using various equipment and circuits.	4	1,2
CO2	Apply appropriate instruments and methods to measure high AC, DC, peak, and impulse voltages accurately.	3	3,4
CO3	Apply techniques and instruments for accurate measurement of high impulse currents and interpret results effectively.	3	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	1
CO2	2	2	2	3	2
CO3	2	2	2	3	1

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Generation of High AC & DC Voltages: Direct Voltages: AC to DC conversion methods electrostatic generators-Cascaded Voltage Multipliers. Alternating Voltages: Testing Transformers-Resonant circuits and their applications, Tesla coil.	
UNIT – 2	Generation of Impulse Voltages: Impulse voltages: Specifications-Impulse generations circuits-Operation, construction, and design of Impulse Generators-Generation of switching and long duration impulses. Impulse Currents: Generation of High impulse currents and high current pulses.	
UNIT – 3	Measurement of High AC & DC Voltages: Measurement of High D.C. Voltages: Series resistance meters, voltage dividers and generating voltmeters. Measurement of High A.C. Voltages: Series impedance meters electrostatic voltmeters potential transformers and CVTS-voltage dividers and their applications.	
UNIT – 4	Measurement of Peak and impulse Voltages: Measurement of Peak Voltages: Sphere gaps, uniform field gaps, rod gaps. Chubb-Fortesque methods. Passive and active rectifier circuits for voltage dividers. Measurement of Impulse Voltages: Voltage dividers and impulse measuring	

	systems-generalized voltage measuring circuits-transfer characteristics of measuring circuits-L.V. Arms for voltage dividers-compensated dividers.	
UNIT – 5	Measurement Impulse Currents: Measurement of Impulse Currents: Resistive shunts-current transformers-Hall Generators and Faraday generators and their applications-Impulse Oscilloscopes.	
	Total	

Text Books:

1. High Voltage Engineering – by E.Kuffel and W.S.Zaengl. Pergaman press Oxford, 1984.
2. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, McGraw-Hill Books Co., New Delhi, 2nd edition, 1995.

Reference Books:

1. High Voltage Engineering – CL Wadhwa, New Age International (P) Limited, Publishers, Second Edition, New Delhi, 2007
2. High Voltage Measuring Techniques – A. Schwab MIT Press, Cambridge, USA, 1972.

M.Tech. I-Semester

COURSE CODE –	DIELECTRICS AND INSULATION ENGINEERING (Program Core–2)	CATEGORY PC	L-T-P 4-0-0	CREDITS 4
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Pre-requisite: Basic Electrical Engineering, Circuit Theory and Electromagnetics.

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

		Knowledge Level (K)#	Related Units
CO1	Explain the physical, thermal, and electrical properties of solid, liquid, and gaseous insulating materials and their applications.	2	1,2
CO2	Analyze the breakdown phenomena in gaseous, vacuum, liquid, and solid dielectrics including key mechanisms like streamer discharge and treeing.	4	3,4
CO3	Apply numerical methods such as Finite Difference, Finite Element, Boundary Element, and Charge Simulation for solving insulation engineering problems.	3	5

Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	3	1
CO2	3	---	3	3	1
CO3	2	---	2	2	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Dielectrics and Insulating Materials: Polarization - Relaxation and resonant models. Solid, Liquid and Gaseous insulating materials-Physical, Thermal & Electrical properties-Classification of Insulating Materials.	
UNIT – 2	Solid Insulating Materials: Organic Fiber materials Ceramics & Synthetic polymers and their applications. Liquid Insulating Materials: Insulating oils, their properties and applications. Gaseous Insulating Materials: Air and SF ₆ - applications in electrical apparatus.	
UNIT – 3	Breakdown phenomenon in gaseous and vacuum insulation: Insulation and decay processes-transition from self-sustained discharges to breakdown-Townsend and streamer discharge Panchen's law, Penning effect-Time lags-Surge breakdown voltage-Breakdown and non-uniform fields-Vacuum insulation and vacuum breakdown.	
UNIT – 4	Breakdown Phenomenon in Liquid and Solid Insulation: pure and commercial liquids-suspended particle and bubble theories-stressed oil volume theory-Breakdown in solid insulation Intrinsic breakdown-Treeing and tracking phenomenon-Thermal breakdown—Breakdown in composite dielectrics.	

UNIT – 5	Numerical techniques: Finite Difference Method, Finite Element Method, Boundary Element Method and Charge Simulation Method.	
	Total	

Text Books:

1. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, Tata McGraw-Hill Books Co., New Delhi, 2nd edition, 1995.
2. Insulating Materials-by Dekker,S. Chanda & Co
3. High Voltage Engineering – by E.Kuffel and W.S. Zaegnl Pergamon press, Oxford, 1984.
4. High voltage and electrical insulation engineering, Ravindra Arora John Wiley & Sons, Inc., 2011

Reference Books:

1. Electrical Engineering Materials – B. Tareev, M.I.R. Publications, MOSCOW.
2. Physics of Dielectrics - B. Tareev, M.I.R. Publications, MOSCOW
3. High Voltage Technology - LL Alston, Oxford University Press 1968.
4. Dielectrics and waves-by vonhipple,John Wiley & Sons

M.Tech. II-Semester

COURSE CODE –	HVDC TRANSMISSION (Program Core-3)	CATEGORY PE	L-T-P 4 -0-0	CREDITS 4
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#	Related Units
CO1	Explain the fundamental principles, components, and configurations of HVDC transmission systems including technical, economical, and reliability aspects.	2	1,2
CO2	Analyze the operation, control, and harmonic performance of converters and HVDC links under various operating conditions.	4	3,4
CO3	Evaluate protection schemes, converter faults, and modern developments such as VSC-based HVDC (HVDC Light) systems for reliable power transmission.	5	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2
CO2	3	1	3	3	3
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Introduction: Limitation of EHV AC Transmission, Advantages of HVDC, Technical economical and reliability aspects. HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration. Types of HVDC links-Apparatus and its purpose	
UNIT – 2	Static Power Converters: 6-pulse bridge circuit and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers.	
UNIT – 3	Control of HVDC Converters and systems: Principles of Control – Necessity of Control in DC link – Rectifier Control - Current Compounding of Rectifiers & Inverters – Power reversal in a DC link – Voltage Dependent Current Order Limit (VDCOL) – Characteristics of the converter – System Control hierarchy – Firing angle control: Individual phase control (IPC) and Equidistant phase control (EPC) - Constant Current Control - Inverter Excitation Angle Control – Pulse phase Control – Starting and Stopping of a DC link – Constant Power Control – Control systems for HVDC converters.	
UNIT – 4	Harmonics in HVDC Systems: Generation of harmonics by 6-pulse & 12-pulse converters – characteristic harmonics on the DC side – characteristic current harmonics	

	– variation of harmonics currents with firing angle & overlap angle – Non characteristic harmonics – Harmonic model and equivalent circuit – use of filters – filter configuration – minimum cost tuned AC filters – DC filters. Multi-Terminal HVDC systems: Types of MTDC systems – series, parallel – parallel operation aspects of MTDC.	
UNIT – 5	Converter Faults and Protection in HVDC Systems: Converter faults – Protection against over current – over voltages in a converter station – surge arresters - over voltages protection in converter station – Transient over voltages in DC line – protection of DC line – DC circuit breakers. HVDC-VSC Transmission Systems (HVDC Light) – HVDC Voltage Source Converters – Principle and operation – Components of VSC.	
	Total	

Text Books:

1. S Kamakshai and V Kamaraju: HVDC Transmission- MG hill.
2. K.R.Padiyar: High Voltage Direct current Transmission, Wiley Eastern Ltd., New Delhi – 1992.

Reference Books:

1. E.W. Kimbark: Direct current Transmission, Wiley Inter Science – New York.
2. J.Arillaga : H.V.D.C. Transmission Peter Peregrinus ltd., London UK 1983
3. Vijay K Sood: HVDC and FACTS controllers: Applications of static converters in power systems by, Kluwer Academic Press.

M.Tech. I-Semester

COURSE CODE –	AI APPLICATIONS IN HIGH VOLTAGE (Program Elective–1 & 2)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Pre-requisite: Basic Electrical Engineering, Control Systems, Mathematics, Programming Fundamentals, Signals and Systems

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

		Knowledge Level (K)#	Related Units
CO1	Describe the fundamentals of Artificial Neural Networks including neuron models, architectures, learning algorithms, and classical/fuzzy set theory.	2	1,3
CO2	Implement various ANN paradigms such as ADALINE, Back Propagation, Radial Basis Function networks, and Fuzzy set operations for classification and pattern recognition tasks.	3	2,3
CO3	Analyze and develop fuzzy logic controllers and AI-based techniques for fault diagnosis, condition assessment, and equipment health ranking using fuzzy logic and neural networks.	4	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	1
CO2	3	2	3	3	3
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT- 1	Introduction Artificial Neural Networks (ANN) – definition and fundamental concepts – Biological neural networks – Artificial neuron – activation functions – setting of weights – typical architectures – biases and thresholds – learning/training laws and algorithms. Perceptron – architectures, ADALINE and MADLINE – linear separability- XOR function.	
UNIT- 2	ANN Paradigms ADALINE – feed forward networks – Back Propagation algorithm- number of hidden layers – gradient decent algorithm – Radial Basis Function (RBF) network. Kohonen’s self organizing map (SOM), Learning Vector Quantization (LVQ) and its types – Functional Link Networks (FLN) – Bidirectional Associative Memory (BAM)-Gradient Descent (GD) Algorithm– Hopfield Neural Network.	
UNIT- 3	Classical and Fuzzy Sets Introduction to classical sets- properties, Operations and relations; Fuzzy sets, Membership, Operations, Properties, Fuzzy relations, Cardinalities, Membership functions.	
UNIT- 4	FUZZY LOGIC CONTROLLER (FLC) Fuzzy logic system components: Fuzzification, Inference engine (development	

	of rule base and decision making system), Defuzzification to crisp sets-Defuzzification methods.	
UNIT– 5	Application of AI Techniques in HV Artificial-intelligence techniques for incipient fault diagnosis and condition assessment: Database for condition assessment- Fuzzy-logic fault diagnosis-Asset analysis and condition ranking-Equipment ranking according to the insulation Condition-Insulation health index	
	Total	

Text Books:

1. Introduction to Artificial Neural Systems - Jacek M. Zurada, Jaico Publishing House, 1997.
2. Fuzzy logic with Fuzzy Applications – T.J Ross – Mc Graw Hill Inc, 1997.
3. R.E.James and Q Su,”Condition Assessment of High Voltage Insulation in Power System Equipment”, IET Power and Energy series 53, 2008.

Reference Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by RajasekharanandPai – PHI Publication.
2. Modern power Electronics and AC Drives – B.K.Bose -Prentice Hall, 2002
3. Genetic Algorithms- David E Goldberg. Pearson publications.
4. Introduction to Neural Networks using MATLAB 6.0 by S N Sivanandam, SSumathi, S N Deepa TMGH
5. Introduction to Fuzzy Logic using MATLAB by S N Sivanandam, SSumathi, S N Deepa Springer, 2007.

M.Tech I-Semester

COURSE CODE –	ENERGY AUDITING, CONSERVATION AND MANAGEMENT (Program Elective–1 & 2)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Pre-requisite: Basic Electrical Engineering

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

		Knowledge Level (K)#	Related Units
CO1	Explain the principles, types, and methodologies of energy auditing along with energy conservation schemes in industries and buildings.	2	1
CO2	Apply energy management techniques, power factor improvement methods, and conduct energy audits on motors, lighting, and electrical systems using relevant instruments.	3	2,3,4
CO3	Analyze the economic aspects of energy management including depreciation, life cycle costing, and payback methods to evaluate energy-efficient projects.	4	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	1
CO2	3	3	3	3	2
CO3	3	2	3	3	2

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT– 1	Basic Principles of Energy Audit Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams and load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.	
UNIT– 2	Energy Management Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting. Energy manager, qualities and functions, language, Questionnaire – check list for top management	
UNIT– 3	Energy Efficient Motors and Lighting Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics – variable speed , variable duty cycle systems, RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. lighting system design and practice, lighting control, lighting energy audit	
UNIT– 4	Power Factor Improvement and energy instruments Power factor – methods of improvement, location of capacitors, Power factor with non-linear loads, effect of harmonics on p.f, p.f motor controllers – Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC's	
UNIT– 5	Economic Aspects and their computation Economics Analysis depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method, net present value	

	method- Power factor correction, lighting – Applications of life cycle costing analysis, return on investment.	
	Total	

Text Books:

1. Energy management by W.R.Murphy&G.Mckay Butter worth, Heinemann publications, 1982.
2. Energy management hand book by W.CTurner, John wiley and sons, 1982.

Reference Books:

1. Energy efficient electric motors by John.C.Andreas, Marcel Dekker Inc Ltd-2nd edition,1995
2. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998
3. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

M.Tech I-Semester

COURSE CODE –	ELECTRIC VEHICLES (Program Elective–1 & 2)	CATEGORY PE	L-T-P 3-0-0	CREDITS 3
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Pre-requisite: Basic Electrical Engineering, Power Systems, Control Systems and Power Electronics.

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

		Knowledge Level (K)#	Related Units
CO1	Describe the fundamentals, components, and types of electric and hybrid electric vehicles including their advantages and applications.	2	1,2,3
CO2	Apply knowledge of Vehicle-to-Grid (V2G), Grid-to-Vehicle (G2V) technologies, and EV charging schemes in real-world energy scenarios.	3	4
CO3	Analyze energy storage technologies and apply fault diagnosis techniques in electric vehicles for system reliability.	4	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	1
CO2	2	2	3	2	2
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT - 1	Introduction Fundamentals of vehicles - Components of conventional vehicles - drawbacks of conventional vehicles – Need for electric vehicles - History of Electric Vehicles – Types of Electric Vehicles – Advantages and applications of Electric Vehicles.	
UNIT - 2	Components of Electric Vehicles (EVs) Main components of Electric Vehicles – Power Converters - Controller and Electric Traction Motor – Rectifiers used in EVs – Bidirectional DC–DC Converters – Voltage Source Inverters.	
UNIT - 3	Hybrid Electric Vehicles Evolution of Hybrid Electric Vehicles – Advantages and Applications of Hybrid Electric Vehicles – Architecture of HEVs - Series and Parallel HEVs – Complex HEVs – Range extended HEVs – Examples - Merits and Demerits.	
UNIT - 4	V2G and G2V Technologies Energy scenario in India, Electricity consumption by EVs and all other loads, End of life batteries for grid support, EV charging schemes, types of EV chargers, Vehicle-to-grid (V2G) and Grid-to-Vehicle (G2V) technologies, Energy trading with EVs.	
UNIT - 5	Energy Sources for Electric Vehicles Batteries - Types of Batteries – Lithium-ion - Nickel-metal hydride - Lead-acid – Comparison of Batteries - Battery Management System – Ultra	

	capacitors – Flywheels – Fuel Cell – it's working. Fault diagnosis-PWM-Stress for insulation	
	Total	

Text Books

1. Iqbal Hussein - Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2021.
2. Denton - Tom. Electric and hybrid vehicles. Routledge - 2020.

Reference Books:

1. Kumar - L. Ashok - and S. Albert Alexander. Power Converters for Electric Vehicles. CRC Press - 2020.
2. Chau - Kwok Tong. Electric vehicle machines and drives: design - analysis and application. John Wiley & Sons - 2015.
3. Berg - Helena. Batteries for electric vehicles: materials and electrochemistry. Cambridge university press - 2015.

M.Tech. I-Semester

COURSE CODE –	HIGH VOLTAGE POWER TRANSFORMERS AND DIAGNOSTICS (Program Elective–1 & 2)	CATEGORY PE	L-T-P 3-0-0	CREDITS 3
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Pre-requisite: Fundamentals of Electrical Machines, Electrical Measurements & Instrumentation, Fundamentals of Signal Processing.

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

		Knowledge Level (K)#	Related Units
CO1	Explain the constructional features, cooling methods, and causes of over voltages and failures in power transformers.	2	1
CO2	Analyze the insulation condition of transformers using insulation resistance tests, moisture estimation, partial discharge measurement, and ageing indicators such as degree of polymerization and furfural content.	4	2,3,4
CO3	Evaluate transformer health and fault conditions through dissolved gas analysis (DGA), frequency response analysis (FRA), and other advanced diagnostic techniques for ensuring reliability and longevity.	5	5

Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	3	2
CO2	3	1	3	3	3
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Introduction to power transformer, important components of power transformer, winding configuration, various types of cooling, cooling Arrangements, Reasons of failure of transformer, overvoltage due to switching operation, over-voltage due to lightning impulse, over voltage due to fault, over fluxing.	
UNIT – 2	Measurement of Insulation Resistance: Spot reading test, Time versus Resistance test, and Stepped Voltage test- Limitations of Insulation Resistance test - Factors Influencing Insulation Resistance. Moisture in transformer oil and paper, Sources of Moisture in Transformer Insulation, ageing effect of paper, methods of moisture reduction, Influence with regard to life of transformer.	
UNIT – 3	Partial Discharges in transformer, causes of partial discharges, concept of partial discharges, Electrical method and acoustic method of measurement of partial discharges. Degree of polymerization (DP) of transformer paper, effect of DP on life of transformer, furfural content in oil insulation, inter – relationship between degree of polymerization and furfural content.	
UNIT – 4	Dissolved Gas Analysis (DGA) in transformer oil, various gas product in	

	transformer oil, Various detection of important gases in transformer, Faults identification using various DGA methods-NTT flag point method, Rogers ratio method and Dual triangle method.	
UNIT – 5	Concept of Fourier Transform with regard to configuration of winding - Frequency Response Analysis (FRA) Measurement Connection Methods, Methods of Frequency Response Analysis: Impulse Frequency Response Analysis (IFRA) and Swept Frequency Response Analysis (SFRA)	
	Total	

Text book:

1. Transformer, Bharat Heavy Electricals Limited (Bhopal), Second edition 2003, First Edition 1987 Tata Mc.Graw-hill Publishing Company Ltd. Mc.Graw –Hill office Page 1- 602
2. Sivaji Chakrovorti, Debangshu Dey, Biswendu Chatterjee, “Recent trends in the condition monitoring of transformers”, Springer-Verlag, London 2013

Reference book:

1. S.V. Kulkarni, S.A. Khaparde, “Transformer Engineering- Design, Technology, and Diagnostics” CRC Press -Taylor & Francis Group, 2nd edition, 2013
2. Seminar on fault finding and life assessment of power transformers Proceedings 25-26 April 2008 New Delhi, Organized by Central Board of Irrigation and Power, New Delhi in association with Omicron India.
3. Transformer Engineering, Blue mend boission, Wiley international publication.

M.Tech. I-Semester

COURSE CODE –	SMART GRIDS (Program Elective–1 & 2)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Pre-requisite: Basic knowledge on smart concept communication protocols, renewable energy systems and electronic circuits.

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

		Knowledge Level (K)#	Related Units
CO1	Explain the fundamental concepts, evolution, and components of Smart Grids, including technologies like Smart Meters, Smart Appliances, and Outage Management Systems (OMS).	2	1,2
CO2	Demonstrate the application of Smart Grid technologies such as Substation Automation, Energy Storage, and Geographic Information Systems (GIS) to enhance grid efficiency.	3	3,4
CO3	Assess the integration of renewable energy, Microgrids, power quality management for optimized Smart Grid operation.	5	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	2	3	3	3
CO3	2	1	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self-Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid.	
UNIT – 2	Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.	
UNIT – 3	Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System (WAMS), Phasor Measurement Unit (PMU).	
UNIT – 4	Microgrids and Distributed Energy Resources: Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid, Integration of renewable energy sources.	
UNIT – 5	Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources,	

	Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.	
	Total	

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press

Reference Books:

1. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley
2. Jean Claude Sabonnadière, Nouredine Hadjsaïd, “Smart Grids”, Wiley Blackwell 19
3. Peter S. Fox Penner, “Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities”, Island Press; 1 edition 8 Jun 2010
4. S. Chowdhury, S. P. Chowdhury, P. Crossley, “Microgrids and Active Distribution Networks.” Institution of Engineering and Technology, 30 Jun 2009
5. Stuart Borlase, “Smart Grids (Power Engineering)”, CRC Press
6. Andres Carvallo, John Cooper, “The Advanced Smart Grid: Edge Power Driving Sustainability: 1”, Artech House Publishers July 2011

M.Tech. I-Semester

COURSE CODE –	ADVANCED ELECTRICAL INSULATION SYSTEMS (Program Elective–1 & 2)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Pre-requisite: Basic Electrical Engineering, Fundamentals of Electrical Insulation, Transmission Systems and power systems

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

		Knowledge Level (K)#	Related Units
CO1	Describe the various types of insulating materials (gases, solids, liquids, and fibrous materials), their properties, and applications in high-voltage systems.	2	1
CO2	Analyze insulation systems for AC, DC, and impulse voltages, including cables, bushings, transformers, and circuit breakers, considering their dielectric properties and effects on system performance.	4	2,3,4
CO3	Evaluate space charge accumulation in HVDC insulation systems and use techniques like Laser Intensity Modulation (LIMM), Thermal Pulse Method, and Pressure Wave Propagation to analyze the effects of space charges.	5	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	2	1
CO2	3	2	3	3	2
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT– 1	Insulating Materials: Gases: air and SF ₆ - Inorganic Solid Insulating Materials- Highly Polymerized Plastics: Thermoplastic Insulating Materials, Thermosetting Materials and Elastomers, Silicones- Insulating Liquids: Mineral Oil, Vegetable oil and Natural Ester Liquids, Liquefied gases- Fibrous Material: Paper and Pressboard, Synthetic Fibrous Materials	
UNIT– 2	Typical Insulation systems for AC Voltages: Cables: Paper-insulated Cables, Plastic-insulated Cables, Gas-insulated Lines (GIL)- Bushings: Field Grading or Potential Grading, Calculation of Capacitive Grading- Transformers: Oil-filled Transformers and Dry-type Transformers, Reactors, Windings and On-load Tap Changer- Capacitors: Structure of the Dielectric, Drying and Impregnation – Circuit breakers: SF ₆ Compressed gas Circuit breaker, Vacuum Circuit breaker	
UNIT– 3	Typical Insulation systems for DC Voltages: Electrical Stress and Strength for DC Voltage: Dielectric Stresses and Strength at DC Voltage, Dielectric Properties of Materials -Capacitors for	

	Direct Voltage (DC Capacitors) - HVDC Transformers: Dielectric Stresses, AC and Steady-state DC Voltage Stresses, Stresses during Voltage Variations - HVDC Bushings: Internal Insulation, External Insulation - HVDC Cables: DC Cables, Paper-insulated HVDC Cables, Plastic-insulated HVDC Cables.	
UNIT– 4	Typical Insulation systems for Impulse Voltages: Electrical Stress and Strength- Energy Storage- Impulse Capacitors (Energy Storage or Surge Capacitors): Capacitor Design, Capacitor Inductance, Dielectric and Service Life,– other applications: Lightning Protection, Electrostatic Particle Precipitation, Ionization	
UNIT– 5	Space Charges in HVDC insulation Space Charge in HVDC Cable Insulation, Space-Charge Accumulation, Charge Generation, Charge Trapping, Thermal Methods: Laser Intensity Modulation Method (LIMM), Thermal Pulse Method, Thermal Step Method (TSM), Pressure Pulse Methods: Pressure Wave Propagation Method, Laser-Induced Pressure Pulse (LIPP) Method, Pulsed Electroacoustic (PEA) Method	
	Total	

Text Books:

1. Kuchler, High Voltage Engineering-Fundamentals, Technology and Application, Springer,2017.
2. R. Aurora, W. Mosch, High Voltage and Electrical Insulation Engineering, Wiley, 2011
3. Du, Polymer Insulation Applied for HVDC Transmission, Springer 2020.
4. Giovanni Mazzanti, Massimo Marzinotto, Extruded Cables for High Voltage Direct Current Transmission Wiley Publication, June 2013.

M.Tech. I-Semester

COURSE CODE –	HIGH VOLTAGE LABORATORY (Laboratory – 1)	CATEGORY PC	L-T-P 0-0-4	CREDITS 2
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Pre-requisite: Basic Electrical Engineering Concepts, Electromagnetic Field Theory and Insulating Materials Basics

Course Outcomes: At the end of the lab, student will be able to

		Knowledge Level (K)#	Related Experiments
CO1	Measure the breakdown voltage, leakage current, insulation resistance, flashover voltage, polarization index, and dielectric constant of various insulating materials and electrode configurations.	3	1, 2, 3, 5, 6, 7, 8, 9, 10, 11
CO2	Analyze the characteristics of uniform and non-uniform electric fields, impulse voltages, and their effects on insulation systems and electrode gaps.	4	1, 2, 3, 5, 6, 7, 8, 9, 10, 11
CO3	Construct and evaluate high-voltage circuits such as voltage multipliers and Tesla coils for generation and analysis of high-voltage phenomena.	5	4, 12, 13

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	3	1
CO2	3	2	3	3	2
CO3	3	2	3	3	2

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

List of Experiments

Any 10 of the following experiments are to be conducted

S.No.	List of Experiments
1	Breakdown test of transformer oil with uniform and non-uniform fields
2	Breakdown Voltage Characteristics of Rod-Rod, Point-Sphere, and Sphere-Sphere Gaps
3	Breakdown Voltage Characteristics of Plane-Rod and Point-Plane Gaps
4	Generation and measurement of standard impulse voltages
5	Measurement of Leakage current and insulation resistance of polypropylene scale
6	Measurement of Leakage current and insulation resistance of polypropylene rope
7	Measurement of leakage current and flashover voltage of porcelain disc insulator
8	Measurement of leakage current and flashover voltage of polymer insulator
9	Measurement of Leakage current and flashover voltage of pin insulator
10	Measurement of polarization index and insulation resistance of electrical insulating materials.
11	Measurement and calculation of the dielectric constant for a given insulating material using capacitance measurements.
12	Construction and testing of a voltage multiplier circuit to analyze its output voltage characteristics.
13	Construction and Operation of Tesla Coil

M.Tech. I-Semester

COURSE CODE –	HV SIMULATION LABORATORY – I (Laboratory – 2)	CATEGORY LB	L-T-P 0-0-4	CREDITS 2
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Pre-requisite: Concepts of high voltage generation, Dielectric materials and measurement techniques.

Course Outcomes: At the end of the lab, student will be able to

		Knowledge Level (K)#	Related Experiments
CO1	Analyze the electric field distribution and breakdown characteristics for various electrode gap configurations	4	1,2,3,4
CO2	Model and simulate electrical systems like impulse voltage/current generation circuits and Tesla coil circuits, and analyze partial discharge phenomena and measurement techniques.	3	8,9,10,11
CO3	Model and simulate insulator behavior, focusing on electric field distribution, aging effects, temperature-dependence, and breakdown mechanisms for different insulator types.	5	5,6,7,12

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	1	1
CO2	3	3	2	1	2
CO3	3	2	3	2	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

Any 10 of the following experiments are to be conducted

List of Experiments

S.No.	CONTENTS
1	Electric Field Analysis of Sphere to Sphere gap
2	Electric Field Analysis of Rod to Rod gap.
3	Electric Field Analysis of Point to Sphere gap.
4	Electric Field Analysis of Plane to Rod gap.
5	Electric Field Analysis of Disc Insulator.
6	Electric Field Analysis of 11kV Polymer Insulator.
7	Electric Field Analysis of Pin Insulator.
8	Simulation of Impulse voltage generation circuit.
9	Simulation of Impulse current generation circuit.
10	Simulation of Tesla coil circuit.
11	Simulation and modeling of Partial Discharge (PD) phenomena and their measurement systems.
12	Simulation and modeling of insulators, considering aging effects and temperature dependent characteristics.

M.Tech. I-Semester

COURSE CODE –	TECHNICAL SEMINAR -I	CATEGORY	L-T-P 0 -2-1	CREDITS 1
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Conduct an in depth literature survey on a chosen technical topic, analyze current trends, and identify research gaps.	3
CO2	Develop and present a coherent technical report and seminar presentation using appropriate tools, adhering to academic standards.	3
CO3	Demonstrate critical thinking, technical understanding, and effective communication skills through seminar discussions and defense of the work.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	1	1
CO2	2	3	2	1	1
CO3	2	2	3	1	1

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

M.Tech. II-Semester

COURSE CODE –	HIGH VOLTAGE TESTING TECHNIQUES (Program Core – 4)	CATEGORY PC	L-T-P 4-0-0	CREDITS 4
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Pre-requisite: Basics of high voltage engineering.

Course Outcomes: At the end of the course, students will be able to

		Knowledge Level (K)#	Related Units
CO1	Explain the principles and applications of non-destructive testing and measurement techniques used in high-voltage engineering.	2	1
CO2	Analyze various high voltage testing methods for power apparatus and insulating materials in accordance with national and international standards and safety practices.	4	2,3
CO3	Evaluate the performance and reliability of high-voltage equipment through AC, impulse, and artificial contamination tests for quality assurance and field performance correlation.	5	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2
CO2	3	2	3	3	2
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Non Destructive Testing Techniques : Measurement of DC Resistivity – Dielectric loss and dielectric constant of insulating materials – Schering bridge method – Transformer ratio arm bridge for high voltage and high current applications – null detectors.	
UNIT – 2	High Voltage Testing of Power Apparatus: Need for testing standards – Standards for porcelain/Glass insulators-Classification of porcelain/glass insulator tests – Tests for cap and pin porcelain/Glass insulators – Measurement of string efficiency.	
UNIT – 3	Standards and safety in high voltage testing-Testing standards: IEC 60060, IEC 60270, IS 2071, IEEE std.4- Test procedures and documentation. Laboratory layout, safety precautions and grounding technologies. RIV Measurements: Radio Interference – RIV – Measurement of RI and RIV in laboratories and in field. Different test arrangements and their limitations.	
UNIT – 4	High voltage AC testing methods-Power frequency tests-Over voltage tests on insulators, Isolators, Circuit Breakers and power cables. Artificial Contamination Tests: Contamination flashover phenomena-Contamination Severity-Artificial contamination tests-Laboratory Testing versus in-Service Performance-Case study.	
UNIT – 5	Impulse Testing: Impulse testing of transformers, insulators, Surge diverters, Bushings, cables, circuit breakers.	
	Total	

Text Books:

1. High Voltage Engineering – by E.KUFFEL and W.S.ZAENGL, Pergamon press, Oxford 1984.
2. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, Tata McGraw Hill Publishing Company Limited, New Delhi – 2001.
3. High Voltage Engineering – by C.L.Wadhwa, New Age International Pvt Ltd Publishers -3rd edition.
4. Outdoor insulators – by Ravi S. Gorur, Edward A.Cherney, Jeffrey T. Burnham, “Outdoor Insulators”, Ravi S. Gorur, Inc., Phoenix, Arizona85044,USA,1999.

Reference Books:

1. Discharge Detection in H.V. Equipment – by KREUGER, F.H. Haywood London – 1964.
2. Ryan H.M. and Whiskand: design and operation perspective of British UHV Lab IEE pre 133 H.V. Testing Techniques Halfly
3. The practical guide to outdoor high voltage insulators – by W L Vosloo et al, crown publications – 2004.
4. Insulators for high voltages by J.S.T. Looms by IET power and energy series
5. IEC 60060 (Parts 1 & 2) – High-voltage test techniques
 - a. IEC 60060-1: High-voltage test techniques – Part 1: General definitions and test requirements.
 - b. IEC 60060-2: High-voltage test techniques – Part 2: Measuring systems.
6. IEC 60270 – High-voltage test techniques – Partial discharge measurements
7. IS 2071 (Part 1–3) – High-voltage test techniques
 - a. IS 2071 (Part 1): General definitions and test requirements.
 - b. IS 2071 (Part 2): Measuring systems.
 - c. IS 2071 (Part 3): Synthetic testing.
8. IEEE Std 4 – IEEE Standard Techniques for High-Voltage Testing

M.Tech. II-Semester

COURSE CODE –	SURGE PHENOMENON AND INSULATION COORDINATION (Program Core – 5)	CATEGORY PC	L-T-P 4-0-0	CREDITS 4
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Pre-requisite: Basic concepts of travelling wave techniques and their applications in electrical power systems, lightening and switching over voltages, insulation co-ordination in power systems.

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

		Knowledge Level (K)#	Related Units
CO1	Analyze the behavior of traveling waves and transient phenomena in transmission lines, including reflections and standing waves in multi-conductor systems.	4	1,2
CO2	Evaluate the mechanisms and effects of lightning and switching surges in power systems, and explain general principles of lightning protection.	5	3
CO3	Demonstrate the methods for surge voltage distribution, insulation coordination, and protective device selection to safeguard power system equipment from overvoltages.	4	4,5

Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	2	3	3	2
CO3	3	2	3	3	2

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Traveling Waves: Transmission line equation, attenuation and distortion point-Typical cases. Reflection of traveling waves: Behaviors of waves at a transaction point-Typical case. Travelling waves on multi conductor systems	
UNIT – 2	Successive Reflections: Reflection lattice, Effect of insulation capacitance. Standing waves and natural frequencies of transmission lines-Transient response of lines and systems with distributed parameters	
UNIT – 3	Lightning Phenomena and over voltage in power systems. Mechanism of the lightning stroke – Mathematical model of the lightning stroke. Over voltages produced in power systems due to lightning – Over voltage due to faults in the system and switching surges. General principles of lightning protection – Tower – Footing resistance – Insulation withstand voltages and impulse flashover characteristics of protective gaps.	
UNIT – 4	Surge Voltage distribution in transformer windings initial and final distribution characteristics: Protection of windings against over voltages. Protection of transmission lines, transformers and rotating machines against over voltages. Use of rod gaps and lightning arresters protective characteristics. Selection of the lightning arresters.	
UNIT – 5	Insulation coordination lightning surge and switching surge characteristics of	

	insulation structures. Geo-metric gap factors test procedures, correlation between insulation for protective levels. Protective devices Zno arresters, valve type-etc., protective tubes	
	Total	

Text Books:

1. Traveling waves of Transmission systems – by LV Bewley. Dover publications Inc., New York (1963).
2. Rakesh Das Begmudre, E.H.V. Transmission Engineering: Wielly Eastern Ltd., New Delhi, (1986).
3. Electrical transients in power systems- by Allan Greenwood

Reference Books:

1. Lewis, w.w., protection of transmission lines and systems against lightning, dover publications, Inc., New York (1965).
2. Diesendorf.W, Insulation Co-ordination ELBS in H.V. Electrical Power Systems , Butter worth publications, London, (1974).

M.Tech. II-Semester

COURSE CODE –	EHVAC TRANSMISSION (Program Core – 5)	CATEGORY PE	L-T-P 4-0-0	CREDITS 4
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Pre-requisite: Transmission line parameters and properties, Corona etc.

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

		Knowledge Level (K)#	Related Units
CO1	Calculate the electrical parameters of EHV AC transmission lines including resistance, inductance, capacitance, and their impact on line performance and losses.	3	1
CO2	Analyze the effects of electrostatic fields and corona phenomena on transmission lines, including biological impacts, noise generation, and wave attenuation.	4	2,3
CO3	Evaluate and design reactive power compensation and voltage control methods in EHV transmission systems, including use of synchronous condensers, series and shunt compensation, and harmonic filtering.	5	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	3	2	3	3	2
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	E.H.V.A.C. Transmission, line trends and preliminary aspects, standard transmission voltages – power handling capacities and line losses – mechanical aspects. Calculation of line resistance and inductance: resistance of conductors, temperature rise of conductor and current carrying capacity. Properties of bundled conductors and geometric mean radius of bundle, inductance of two conductor lines and multi conductor lines, Maxwell's coefficient matrix. Line capacitance calculation. Capacitance of two conductor line, and capacitance of multi conductor lines, potential coefficients for bundled conductor lines, sequence inductances and capacitances and diagonalization.	
UNIT – 2	Calculation of electro static field of AC lines in the space - Effect of high electrostatic field on biological organisms and human beings. Surface voltage Gradient on conductors, surface gradient on two conductor bundle and cosine law, maximum surface voltage gradient of bundle with more than 3 sub conductors, Mangolt formula.	
UNIT – 3	Corona : Corona in EHV lines – corona loss formulae –exact loss formula using charge voltage diagram, attenuation of traveling waves due to corona – Audio noise due to corona, its generation, characteristics and limits, measurement of audio noise.	
UNIT – 4	Power Frequency voltage control : Problems at power frequency, generalized	

	constants, No load voltage conditions and charging currents, voltage control using synchronous condenser, cascade connection of components : Shunt and series compensation, sub synchronous resonance in series – capacitor compensated lines	
UNIT – 5	Reactive power compensating systems: Introduction, SVC schemes, Harmonics injected into network by TCR, design of filters for suppressing harmonics injected into the system. Grounding Grid Design for Substations- Principles and objectives of grounding in substations-Design criteria for grounding grids.	
	Total	

Text Books:

1. Extra High Voltage AC Transmission Engineering – Rakesh Das Begamudre, Wiley Eastern ltd., New Delhi – 1987.
2. Ultra-high Voltage AC/DC power transmission – Hao Zhou et al., Springer publishers -2018

M.Tech. II-Semester

COURSE CODE –	PARTIAL DISCHARGE IN HV EQUIPMENT (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3-0-0	CREDITS 3
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Pre-requisite: Basic Electrical Engineering / Power Systems, Basic Electromagnetic Theory, Insulation Materials and Knowledge in High Voltage fundamentals.

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

		Knowledge Level (K)#	Related Units
CO1	Classify the types of partial discharges, their inception, recurrence, and magnitudes under different voltage conditions.	2	1,2
CO2	Analyze the principles of electrical discharge detection, including detection circuits, sensitivity, and methods to distinguish true signals from interferences.	4	3
CO3	Apply various techniques for locating partial discharges in power apparatus and evaluate discharge severity for different equipment under real conditions.	3	4,5

Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	1
CO2	3	2	3	3	2
CO3	3	2	3	3	2

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Types of partial discharges and its occurrence and recurrence and magnitudes: Definition of Partial discharges, inception of internal discharges, Inception of corona discharges.	
UNIT – 2	Discharges by electrical treeing. Discharges at AC Voltages, corona discharges, Discharges at D.C. Voltages, discharges at impulse voltages. Object of discharge detection, Quantities related to the magnitude of discharges, choice of PD as a measure for discharges.	
UNIT – 3	Electrical discharge detection & Detection circuits : Basic diagram, amplification of impulses, sensitivity, resolution, observation. Straight detection. Balanced detection, calibrators, Interferences, choice between straight detection & balance detection, common mode rejection.	
UNIT – 4	Location of Partial discharges: Non-electric location, location by separation of electrodes, location with electrical probes. Location by traveling waves, PD location in cables & switchgear by traveling waves. Evaluation of discharges: Recognition, mechanisms of deterioration, evaluation, specification.	
UNIT – 5	Detection in actual specimen: Detection in capacitors, cables, bushings. Transformers, machine insulation, Gas-insulated switchgear.	
	Total	

Text Books:

1. Partial Discharges in HV Equipment by F.Kruguer, Butterworths& Co., Publications Ltd., 1989.
2. Partial Discharges in Electrical Power Apparatus. by Dieter Konig, Y. NarayanaRao-VDE-Verlag publisher
3. High Voltage Engineering – by E.Kuffel and W.S.Zaengl. Pergaman press Oxford, 1984.

M.Tech. II-Semester

COURSE CODE –	CONDITION MONITORING OF HIGH VOLTAGE POWER EQUIPMENT (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Pre-requisite: Basics concepts of power systems and dielectrics

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

		Knowledge Level (K)#	Related Units
CO1	Explain the principles of insulation deterioration, failure mechanisms, and the necessity for condition monitoring in power system equipment.	2	1,2,3
CO2	Analyze various electrical, physical, and chemical diagnostic methods for detecting insulation defects and assessing insulation condition in power equipment.	4	3,4
CO3	Apply online insulation condition monitoring techniques and asset management strategies to enhance the reliability and life of power system equipment.	3	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	1
CO2	3	2	3	3	2
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Introduction: Need for Condition monitoring, Predictive maintenance, Characterization of insulation condition, Modes of deterioration and failure of practical insulating Materials, Overview of insulation design requirements, Electric stress distributions in simple insulation systems and Electric stress control.	
UNIT – 2	Insulation defects in power-system equipment- Suspension and post insulators, High-voltage bushings, High-voltage instrument transformers, High-voltage power capacitors, High-voltage surge arresters, High-voltage circuit breakers, Gas-insulated systems, High-voltage cables.	
UNIT – 3	Insulation defects in rotating machines- Possible insulation failure mechanisms in rotating machines. Insulation defects in Transformers. Non-destructive electrical measurements- Insulation resistance (IR) measurements-Measurements of the dielectric dissipation factor (DDF)-Measurement of partial discharges by electrical methods-Dielectric response measurements	
Unit-4	Physical and chemical diagnostic methods- Indicators of in-service condition of oil–paper Systems-Analysis of SF6 samples from GIS-Surface deterioration of composite insulators-Water treeing in XLPE cable insulation-Ultrasonic methods for detection of partial discharges. Sensors for insulation condition monitoring- Ultra-high-frequency sensors,	

	Optical-fibre sensors, Directional sensors for PD measurements	
UNIT – 5	Online insulation condition monitoring techniques -problems with offline condition monitoring, Noise-mitigation techniques, Non-electrical online condition monitoring, Online acoustic/electric PD location methods for transformers, Electrical online condition monitoring and periodic monitoring, Asset management	
	Total	

Text Books:

1. R.E.James and Q Su,”Condition Assessment of High Voltage Insulation in Power System Equipment”, IET Power and Energy series 53, 2008.
2. Sivaji Chakrovorti, DEbangshuDey, Biswendu Chatterjee,” Recent trends in the condition monitoring of transformers”, Springer-Verlag, London 2013.

Reference Books:

1. T.S. Ramu, Partial Discharge Based Condition Monitoring of High Voltage Equipment, New age International Publishers, 2010.

M.Tech. II-Semester

COURSE CODE –	OUTDOOR HIGH VOLTAGE INSULATORS (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Pre-requisite: Basics of Power systems

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

		Knowledge Level (K)#	Related Units
CO1	Describe various types of insulators, their materials, construction, and electrical characteristics including voltage distribution and string efficiency.	2	1,2
CO2	Analyze environmental factors affecting insulator performance such as pollution, weather, and biological influences, and their impact on material selection and site assessment.	4	3,4
CO3	Evaluate different pollution mitigation techniques and recommend suitable methods for maintaining insulator performance and reliability.	5	4,5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	1	1
CO2	3	2	3	3	2
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT– 1	Insulator Types and Characteristics: Insulator Materials: Porcelain, Toughened glass, Epoxy resin, Polymer composites, Fundamental Physical Aspects: Dry Arcing distance, Creepage distance, Insulator class. Insulator Types: Pin insulator, Line post insulator, Composite line post insulator, Cap-and-pin (disc) insulator, Long rod insulator, Composite long rod insulator, Station post insulator, Pedestal post insulator, Bushing, Apparatus (hollow) insulator, Stay (guy) wire insulator, Guy strain insulator - Insulator Sheds - Insulator End Fittings, Voltage distribution of a string insulator, String efficiency.	
UNIT– 2	Electrical Considerations Dry and Wet Power Frequency Flashover - Lightning and Switching Impulse Flashover - Power Frequency Pollution Flashover- Other Electrical Considerations: Risk of puncture, Corona, Resistance to power arc damage, Snow and ice flashover, Instantaneous or rapid conductive fog flashover, Bird streamer flashover Lightning-induced back flashovers, Voltage transfer, Temporary Over Voltages (TOV)	
UNIT– 3	Environmental & Material Considerations Pollution: Pre-deposit pollution, Instantaneous pollution, Pollution sources - Weather- Site Severity Assessment: Surface pollution deposit technique - Other	

	pollution assessment methods Other Environmental Considerations: Bird streamers, Birds, rodents and termites, Soil resistivity, Seismic activity, Corrosion, Vandalism. Porcelain: Porcelain manufacture and properties, Construction of porcelain insulators. Glass: Glass manufacture and properties, Construction of glass insulators Polymeric Insulators : Composite insulators, Resin insulators - Metal Fittings	
UNIT– 4	Insulator Selection and Specification Insulator Type and Material: Pollution types and severity, Lightning severity, Vandalism - Insulator Characteristics: Electrical characteristics, Mechanical characteristics, Physical characteristics- Insulator Selection Chart Insulator Specification.	
UNIT– 5	Pollution Mitigation Techniques Insulator Replacement, Cleaning, Silicone Greasing, RTV Coating, Creepage / Shed Extenders, Insulator Upgrading, Mitigation Method Selection	
	Total	

Text Books:

1. The practical guide to outdoor high voltage insulators – by W L Vosloo et al, crown publications – 2004.
2. Ravi S. Gorur, “Outdoor Insulators”, Inc. Phoenix, Arizona 85044, USA, 1999 Working Group D1.44, “Pollution test of naturally and artificially contaminated insulators” Cigre 2017

Reference Books:

1. Looms, J.S.T., “Insulators for High Voltages”, IET, London, U.K 1988.
2. Kuffel, E., Zaengl, W.S. and Kuffel J., “High Voltage Engineering Fundamentals”, Elsevier India Pvt. Ltd, 2005
3. Kind and Karner, “High Voltage Insulation”, Translated from German by Y.Narayana Rao, Frider. Vieweg, & Sohn, Braunschweig, Weishaden, 1985.
4. High Voltage Engineering – by M.S.Naidu and V.Kamaraju, McGraw-Hill Books Co., New Delhi, 5th edition..

M.Tech. II-Semester

COURSE CODE –	FACTS CONTROLLERS (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Pre-requisite: Concepts on Power Electronics and Power Systems

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

		Knowledge Level (K)#	Related Units
CO1	Explain the principles, objectives, and types of FACTS controllers used to enhance controllability, power flow, and stability in AC transmission systems.	2	1
CO2	Analyze the operation, control characteristics, and performance of shunt and series compensators such as SVC, STATCOM, TCSC, and GSC under various system conditions.	4	2,3,4
CO3	Evaluate the effectiveness of advanced FACTS devices like the Unified Power Flow Controller (UPFC) and Interline Power Flow Controller (IPFC) for dynamic stability improvement and optimal power flow control.	5	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2
CO2	3	2	3	3	3
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	FACTS concepts, Transmission interconnections, power flow in an AC System, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.	
UNIT – 2	Static shunt compensation : Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, methods of controllable VAr generation, variable impedance type static VAr generation, switching converter type VAr generation, hybrid VAr generation.	
UNIT – 3	SVC and STATCOM: The regulation slope, transfer function and dynamic performance, transient stability enhancement and power oscillation damping, operating point control and summary of compensation control.-	
UNIT – 4	Static series compensators: Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, functional requirements. GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC), control schemes for GSC, TSSC and TCSC	
UNIT – 5	Unified Power Flow Controller: Basic operating principle, conventional transmission control capabilities, independent real and reactive power flow control, comparison of the UPFC to series compensators and phase angle regulators. Introduction to Inter line Power Flow Controller (IPFC)	

	Total	
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Text Books:

1. “Understanding FACTS Devices” N.G.Hingorani and L.Guygi, IEEE Press. Indian Edition is available:--Standard Publications
2. FACTS Controllers in Power Transmission and Distribution, K.R. Padiyar, New Age International Publishers, 2016
3. Thyristor- Based FACTS controllers for electrical transmission systems, R. Mohan Mathur and Rajiv K. Varma, IEEE Press, 2002

Reference Books:

1. Sang.Y.H and John.A.T, “Flexible AC Transmission systems” IEEE Press (2006).
2. HVDC & FACTS Controllers: applications of static converters in power systems- Vijay K.Sood- Springer publishers

M.Tech. II-Semester

COURSE CODE –	RENEWABLE ENERGY TECHNOLOGIES (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Pre-requisite: Basics of Power Systems

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

		Knowledge Level (K)#	Related Units
CO1	Explain the fundamental concepts, economic considerations, and grid integration requirements of renewable energy systems including wind, tidal, wave, solar, and fuel cells.	2	1
CO2	Analyze the performance, site selection, and operational characteristics of renewable energy conversion systems, including MPPT techniques and environmental impacts.	4	2,3,4
CO3	Evaluate the feasibility, efficiency, and practical implementation aspects of renewable energy technologies and storage systems for sustainable power generation.	5	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2
CO2	3	2	3	3	3
CO3	3	2	3	3	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT – 1	Introduction: Renewable Sources of Energy; Distributed Generation; Renewable Energy Economics - Calculation of Electricity Generation Costs; Demand-Side Management Options; Supply-Side Management Options; Control of renewable energy-based power Systems; grid codes for synchronization, energy scenario in India and Abroad.	
UNIT – 2	Wind Power Plants: Site Selection; Evaluation of Wind Intensity; Topography; Purpose of the Energy Generation-Betz limit- General Classification of Wind Turbine - Generators and Speed Control Used in Wind Power Energy, Analysis of Small wind energy conversion system, MPPT schemes.	
UNIT – 3	Tidal Power: Power generation from barrages – Environmental considerations for tidal barrages – Integration of electrical power from tidal barrages – Tidal Lagoons – Tidal streams/currents Wave Energy: Physical Principles of Wave Energy - Wave Energy Technologies – Arrays – Environmental Impact – Integration.	
UNIT – 4	Photovoltaic Power Plants: Solar Energy; Generation of Electricity by Photovoltaic Effect; Dependence of a PV Cell on Temperature and irradiance input-output Characteristics - Equivalent Models and Parameters for Photovoltaic Panels; MPPT schemes: P&O, INC, effect of partial shaded condition. Applications of Photovoltaic Solar Energy-Economical Analysis of Solar Energy	

UNIT – 5	Fuel Cells: The Fuel Cell; Low- and High-Temperature Fuel Cells; Commercial and Manufacturing Issues - Constructional Features of Proton Exchange-Membrane Fuel Cells; Reformers; Electrolyzer Systems; Advantages and Disadvantages of Fuel Cells - Fuel Cell Equivalent Circuit; Practical Determination of the Equivalent Model Parameters; Aspects of Hydrogen for storage	
	Total	

Text Books:

1. Felix A. Farret, M. Godoy Simoes, Integration of Alternative Sources of Energy, John Wiley & Sons, 2006.
2. Stephen peake, Renewable Energy- Power for a Sustainable Future, Oxford Press,2018

Reference Books:

1. Gilbert M. Masters, Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004.
2. Remus Teodorescu, Marco Liserre, Pedro Rodríguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.

M.Tech. II-Semester

COURSE CODE –	NANO DIELECTRICS (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Pre-requisite: Dielectric Insulation Engineering

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

		Knowledge Level (K)#	Related Units
CO1	Explain the methods of preparing nano composite insulating materials, their dielectric, thermal, and mechanical property enhancements, and applications in power and electronics sectors.	2	1,2
CO2	Analyze the structure–property relationships of polymer/nanofiller interfaces and the effects of nano-filler addition on thermal, mechanical, and insulating performance of polymers.	4	3,4
CO3	Evaluate the performance of nanocomposite insulating materials using computational simulation techniques and assess their environmental and health impacts.	5	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2
CO2	3	2	3	3	3
CO3	3	2	3	2	3

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

UNIT	CONTENTS	Contact Hours
UNIT– 1	Introduction Methods of Mixing Quasi-Cubic Nanofillers - Methods of Mixing Layered Nanofillers-Change in Dielectric and Insulating Properties with Nanofiller Addition- Thermal Expansion Coefficient and withstanding Electric Stress	
UNIT– 2	Applications in Electric Power and Electronics Sectors: Power Apparatus and Cables: Gas, Oil, Solid insulation system, Nanocomposite XLPE Insulated Power Cables - Polymer Insulators for Outdoor Use: Improvement of Erosion Resistance and Bonding in Interfaces using Nanofiller addition.	
UNIT– 3	Thermal and Mechanical Performance of Nanocomposite Insulating Materials: Thermal Performance- Thermal characteristics, thermal properties- Epoxy Resin Thermal characteristics with the use of Nanofiller: Effects of several types of nanofillers on the glass transition temperature - Thermal characteristics of Several Types of Polymers by the dispersion Nanofillers: Room Temperature Vulcanizing silicones, Polypropylene, Polyethylene Mechanical Performance- Improvement of Tensile Strength, Flexure Performance and Suppression.	
UNIT– 4	Structures of Polymer/Nanofiller Interfaces: Interfaces - Interfaces Formed by Inorganic Fillers and Organic Polymers- Various Interfacial Models: Two-layered interfacial model, Multi-core model, Water shell model - Physicochemical Analysis Methods for Interfaces: Evaluation of Shapes, Sizes and Dispersion by SEM and TEM, Estimation of Filler Content by Measuring the Density of Nanocomposites.	
UNIT– 5	Computer Simulation Methods to Visualize Nanofillers in Polymers: Non-Empirical Molecular Orbital Method - Simulation of Performance of	

	Nanocomposites by Coarse-Grained Molecular Dynamics Environmental Concerns: Effects of Nanofillers on Human Body and Environment, Risk Evaluation of Nanofillers	
	Total	

Text Book:

1. Advanced Nanodielectrics Fundamentals and Applications, by Toshikatsu Tanaka and Takahiro Imai, PAN Stanford Publications, 2017.
2. Nanoporous materials: Advance techniques for characterization, Modeling and Processing Edited by Nick KanelloPoulos. CRC press, 2011.

Reference Books:

1. Handbook of Nanofabrication. Edited by Gary Wiederrcht. Elsevier, 2010.
2. Nanocomposite Science and Technology: by P.M. Ajayan, L.S. Schadler, P.V.Braun, 2003 WILEY-VCH Verlag GmbH Co. KGaA, Weinheim.
3. Inorganic Nanoparticles: Synthesis, Application and Perspectives. Edited by Claudia Altavilla and Enrico Ciliberto. CRC Press, 2011.
4. Polymer nanocomposites: by Yiu-Wing Mai and Zhong-Zhen Yu, First published 2006, Woodhead Publishing Limited and CRC Press LLC, USA.
5. CRC Handbook of Thermoelectrics, Ed. CR Rowe.

M.Tech. II-Semester

COURSE CODE –	ADVANCED HIGH VOLTAGE LABORATORY (Laboratory – 3)	CATEGORY PC	L-T-P 0-0-4	CREDITS 2
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Pre-requisite: Basic Concepts of High voltage generation and measurements.

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

		Knowledge Level (K)#
CO1	Design and evaluate various high voltage generating circuits and resonance circuit using modern simulating tools	5
CO2	Analyze the effect of stray capacitance on the high voltage dividers.	4
CO3	Analyze the performance curves of PV module and array with varying the temperatures and irradiances.	4

Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	3
CO2	3	1	3	2	2
CO3	3	1	3	1	2

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

List of Experiments

Any 10 of the following experiments are to be conducted

S.No.	List of Experiments
1	Voltage distribution across a suspension insulator string
2	Wet power frequency testing on polymer insulator string
3	Dry lightning impulse testing on polymer insulator string
4	Wet switching impulse testing on polymer insulator string
5	Artificial contamination testing on porcelain insulator string
6	Generation and measurement of non-standard impulse voltages
7	Incline plane tracking testing on polymer material
8	Contact angle measurement of water molecule on polymer material
9	Tensile testing on polymer insulator
10	Corona testing on insulator string
11	Measurement of Resistivity, Equivalent Salt Deposit Density (ESDD) and Non-soluble deposit density (NSDD) of polluted water sample
12	Millivolt drop test and Tong tester calibration
13	Measurement of tan delta and dielectric constant

M.Tech. II-Semester

COURSE CODE –	HV SIMULATION LABORATORY – II (Laboratory – 4)	CATEGORY LB	L-T-P 0-0-4	CREDITS 2
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Pre-requisite: Concepts of High voltage and Renewable energy sources

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

		Knowledge Level (K)#
CO1	Design and evaluate various high voltage generating circuits and resonance circuit using modern simulating tools	5
CO2	Analyze the effect of stray capacitance on the high voltage dividers.	4
CO3	Analyze the performance curves of PV module and array with varying the temperatures and irradiances.	4

Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	3
CO2	3	1	3	2	2
CO3	3	1	3	1	2

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

List of Experiments

Any 10 of the following experiments are to be conducted

S.NO.	CONTENTS
1	Simulation of Cockroft-Walton Voltage Multiplier circuit for generation of DC high voltage
2	Simulation of Voltage doubler circuit
3	Simulation of Resonance circuit for AC high voltages
4	Study the effect of stray capacitance on the high voltage dividers.
5	Simulation of Marx circuit for impulse voltages.
6	Development of model for PV module and simulation of performance curves and their variation with temperature and irradiation.
7	Development of model for PV array and simulation of performance curves and their variation with temperature and irradiation.
8	Develop a model for a wind turbine generator and simulate its performance curves.
9	Analyze the effect of partial shading condition of a PV module.
10	Simulate the Maximum Power Point tracking of PV module using INC Algorithm.

M.Tech. II-Semester

COURSE CODE –	TECHNICAL SEMINAR -II	CATEGORY	L-T-P 0 -2-1	CREDITS 1
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Conduct an in depth literature survey on a chosen technical topic, analyze current trends, and identify research gaps.	3
CO2	Develop and present a coherent technical report and seminar presentation using appropriate tools, adhering to academic standards.	3
CO3	Demonstrate critical thinking, technical understanding, and effective communication skills through seminar discussions and defense of the work.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	1	1
CO2	2	3	2	1	1
CO3	2	2	3	1	1

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

M.Tech. III-Semester

COURSE CODE –	RESEARCH METHODOLOGY AND IPR	CATEGORY CC	L-T-P 3-0-0	CREDITS 3
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M.Tech. III-Semester

COURSE CODE –	Summer Internship/ Industrial Training (8-10 weeks)	CATEGORY	L-T-P	CREDITS 3
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Apply engineering concepts and problem-solving skills to practical challenges encountered during industry exposure.	3
CO2	Develop technical and professional skills through hands-on experience in an industrial environment.	4
CO3	Communicate effectively by documenting and presenting technical work and collaborating professionally in a team setting.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	--	2	2	2
CO2	3	--	2	2	2
CO3	1	3	1	--	--

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

M.Tech. III-Semester

COURSE CODE –	Comprehensive Viva	CATEGORY	L-T-P	CREDITS 2
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Demonstrate comprehensive understanding and clarity in responding to technical questions during oral communication.	3
CO2	Analyze and synthesize information to critically discuss a specific engineering topic, integrating interdisciplinary concepts.	4
CO3	Communicate technical ideas clearly and professionally, exhibiting ethical standards and confidence during oral examination.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	--	3	1	1
CO2	3	--	3	2	2
CO3	2	3	2	--	--

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)

M.Tech. III & IV-Semester

COURSE CODE –	DISSERTATION-PART A&B	CATEGORY PJ	L-T-P 0-0-52	CREDITS 26
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Identify and define a significant engineering problem through critical literature review and domain analysis, aligned with current technological or industrial needs.	4
CO2	Develop and apply advanced modeling, simulation, and experimental methods to design and validate effective engineering solutions.	6
CO3	Prepare and present technical documentation and research findings effectively, demonstrating academic integrity, ethical conduct, and professionalism.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	--	3	2	2
CO2	3	--	3	3	3
CO3	2	3	2	1	1

(Please fill the above with Levels of Correlation, viz., 3: Strong, 2: Moderate, 1: Weak)