

ACADEMIC REGULATIONS COURSE STRUCTURE AND DETAILED SYLLABUS

ELECTRICAL AND ELECTRONICS ENGINEERING
for

M.Tech. – Advanced Electrical Power System
(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 education for meeting the needs of academic, research and industry in the areas of Electrical & Electronics Engineering, and make the department a centre of academic excellence.

Mission:

1. To provide the requisite theoretical and practical knowledge by offering appropriate courses.
2. To promote research oriented innovation culture among the students.
3. To create social awareness and ethical values in the graduates for betterment of the society.
4. To help the students in building professional capabilities in Electrical & Electronics Engineering.

Program Educational Objectives (PEOs)

PEO1	To enable the students to learn the contemporary concepts of electrical power systems.
PEO2	To train the students with state-of-the-art concepts of power systems to carry out research and development activities.
PEO3	To impart knowledge for enabling the students to work in a collaborative and interdisciplinary environment.

Mapping of PEOs with Mission statements

	PEO1	PEO2	PEO3
M1	3	3	2
M2	2	3	3
M3	2	2	3
M4	3	2	3

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

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	Demonstrate the ability to identify, analyze, and solve complex power system problems using advanced tools and techniques applicable to real-time scenarios
PO5	Develop models and perform comprehensive analysis of power systems integrated with renewable energy sources, leveraging state-of-the-art technologies and methodologies.

Mapping of Program Outcomes to PEOs

Program Outcomes (PO's)	Program Education Objectives (PEOs)		
	PEO1	PEO2	PEO3
PO1	3	3	2
PO2	2	3	2
PO3	3	3	2
PO4	3	3	2
PO5	3	3	3

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

M.Tech Program Course Structure & Syllabus

COURSE STRUCTURE**M.Tech I – Semester**

S. No	Course Code	Course Title	L	T	P	C
1		Program Core – 1 Advanced Power System Operation & Control	3	1	0	4
2		Program Core – 2 Renewable Energy Systems & Technologies	3	1	0	4
3		Program Core – 3 Real Time Control of Power Systems	3	1	0	4
4		Program Elective – 1	3	0	0	3
5		Program Elective – 2	3	0	0	3
6		Laboratory – 1 Power System Simulation Laboratory – I	0	0	4	2
7		Laboratory – 2 Power Systems Laboratory	0	0	4	2
8		Technical Seminar-I	0	0	2	1
		TOTAL	15	5	6	23

Program Elective – 1 & 2

- i. Electrical Distribution Automation
- ii. Reactive Power Compensation and Management
- iii. Electric Vehicles
- iv. Power Electronic Converter
- v. Power Systems Dynamics & Stability
- vi. Evolutionary Algorithms in Power Systems

M.Tech II – Semester

S. No	Course Code	Course Title	L	T	P	C
1		Program Core – 4 Advanced Power Systems Protection	3	1	0	4
2		Program Core – 5 Smart Grid Technologies	3	1	0	4
3		Program Core – 6 Flexible AC Transmission Systems	3	1	0	4
4		Program Elective – 3	3	0	0	3
5		Program Elective – 4	3	0	0	3
6		Laboratory – 3 Power System Simulation Laboratory – II	0	0	4	2
7		Laboratory – 4 Renewable Energy Technologies Laboratory	0	0	4	2
8		Technical Seminar-II	0	0	2	1
		TOTAL	15	5	6	23

Program Elective – 3 & 4

- i. EHVAC & DC Transmission
- ii. AI Applications in Power Systems
- iii. Restructured Power Systems
- iv. Battery Management systems and charging stations
- v. Data driven Power Systems
- vi. Energy Storage Technologies

M.Tech III – Semester

S. No.	Course Code	Course Title	L	T	P	C
1		Research Methodology and IPR / Swayam 12 week MOOC course – RM&IPR	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

M.Tech IV – Semester

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

% External Assessment

COURSE CODE – R2511XXYY	ADVANCED POWER SYSTEM OPERATION & CONTROL (Program Core – 1)	CATEGORY PC	L-T-P 3-1-0	CREDITS 4
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Analyze and solve unit commitment and optimal power flow problems considering system constraints and economic dispatch criteria.	4
CO2	Design and evaluate single-area and two-area load frequency control schemes, including AGC and economic dispatch control under different operating conditions.	5
CO3	Apply optimization techniques to generation scheduling and interchange evaluation, including fuel constraints, power pooling, and economy transactions in large-scale power systems.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

UNIT	CONTENTS	Contact Hours
UNIT – 1	Commitment problem and optimal power flow solution: Unit commitment: Constraints in UCP, UC solution methods. Priority list method, Dynamic programming Approach (upto 3 Units). Optimal power flow: OPF without inequality constraints, inequality constraints on control variables and dependent variables.	
UNIT – 2	Single area Load Frequency Control: Necessity of keeping frequency constant. Definition of control area, single area control, Block diagram representation of an isolated Power System, Steady State analysis, Dynamic response-Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation, steady state response.	
UNIT – 3	Two area Load Frequency Control: Block Diagram development of two-area system, uncontrolled case and controlled case, tie-line bias control, steady state representation. Optimal two-area LF control-performance Index and optimal parameter adjustment. Load frequency control and Economic dispatch control.	
UNIT – 4	Generation with limited Energy supply: Take-or-pay fuel supply contract, composite generation production cost function. Solution by gradient search techniques, Hard limits and slack variables, Fuel scheduling by linear programming.	

UNIT – 5	Interchange Evaluation and Power Pools Economy Interchange: Economy interchange Evaluation, Interchange Evaluation with unit commitment, Multiple Interchange transactions, Other types of Interchange, power pools, transmission effects and issues.	
	Total	

Text Books:

1. Power Generation, Operation and Control - by A.J.WoodandF.Wollenberg, Johnwiley& sons Inc. 1984.
2. Modern Power System Analysis - by I.J.Nagrath & D.P.Kothari, Tata McGraw-Hill Publishing Company ltd, 2nd edition.

Reference Books:

1. Power system operation and control PSR Murthy B.S publication.
2. Electrical Energy Systems Theory - by O.I.Elgerd, Tata McGraw-Hill Publishing Company Ltd, 2nd edition.
3. Reactive Power Control in Electric Systems - by TJE Miller, John Wiley & sons.

COURSE CODE – R2511XXYY	RENEWABLE ENERGY SYSTEMS & TECHNOLOGIES (Program Core – 2)	CATEGORY PC	L-T-P 3-1-0	CREDITS 4
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Pre-requisite: Knowledge on Power Generation Engineering, Power Transmission Engineering.

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

		Knowledge Level (K)#
CO1	Analyze and compare the design, operation, and integration of renewable energy systems including wind, photovoltaic, and fuel cell technologies, evaluating their technical and economic impacts on modern power grids.	4
CO2	Apply fundamental principles and mathematical models to size, implement, and optimize the operation of distributed renewable power plants, including load analysis, resource assessment, and performance evaluation.	3
CO3	Evaluate the operational challenges and solutions for integrating diverse renewable energy technologies—such as induction generators, PV, and fuel cells—into interconnected and stand-alone power systems, considering control, management, and reliability aspects.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2		3	3	2
CO2			3	3	3
CO3	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	Alternative Sources of Energy: 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	
UNIT-2	Wind Power Plants: Appropriate Location; Evaluation of Wind Intensity; Topography; Purpose of the Energy Generated – Wind Power-General Classification of Wind Turbines; Rotor Turbines; Multiple-Blade Turbines; Drag Turbines; Lifting Turbines - Generators and Speed Control Used in Wind Power Energy; Analysis of Small wind energy conversion system, MPPT schemes.	
UNIT – 3	Induction Generators: Principles of Operation; Representation of Steady-State Operation; Power and Losses Generated - Self-Excited Induction Generator; Magnetizing Curves and Self-Excitation - Mathematical Description of the Self-Excitation Process; Interconnected and Stand-alone operation - Speed and Voltage Control, Back-Back	

	converters.	
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	Power Plants With Fuel Cells: The Fuel Cell; Practical Issues Related to Fuel Cell Stacking; 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 as Fuel, Future perspectives.	
	Total	

Text Books:

1. Felix A. Farret, M. Godoy Simões, Integration of Alternative Sources of Energy, John Wiley & Sons, 2006.
2. Remus Teodorescu, Marco Liserre, Pedro Rodríguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley & Sons, 2011.

Reference Books:

1. Gilbert M. Masters, Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004.

COURSE CODE – R2511XXYY	REAL TIME CONTROL OF POWER SYSTEMS (Program Core – 3)	CATEGORY PC	L-T-P 3 -1-0	CREDITS 4
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Analyze real-time state estimation techniques, security assessment, and contingency evaluation to enhance reliability and situational awareness in modern power systems.	4
CO2	Apply the concepts and tools of computer control, SCADA, and energy management systems for the efficient operation, monitoring, and automation of power networks in real time.	3
CO3	Evaluate power system voltage stability, operational states, and market mechanisms—such as deregulation and economic operation—using advanced tools for assessing the dynamic performance and economic operation of power systems.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	3	2
CO2	1	2	3	3	3
CO3	2	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	State Estimation: Different types of State Estimations, Theory of WLS state estimation, State Estimation of an AC Network, State Estimation by Orthogonal Decomposition, Network Observability and Pseudo measurements, Bad data detection, identification and elimination.	
UNIT – 2	Security and Contingency Evaluation: Security concept, Security Analysis and monitoring, Contingency Analysis for Generator and line outages by iterative linear power flow method, Fast Decoupled model, and network sensitivity methods.	
UNIT – 3	Computer Control of Power Systems: Need for real time and computer control of power systems, operating states of a power system, Supervisory Control And Data Acquisition (SCADA) systems implementation considerations, energy control centers, software requirements for implementing the above functions.	
UNIT – 4	Voltage Stability: voltage collapse, and voltage security, relation of voltage stability to rotor angle stability. Voltage stability analysis Introduction to voltage stability analysis 'P-V' curves and 'Q-V' curves, voltage stability in mature power systems, long-term voltage stability, power flow analysis for voltage stability, voltage stability static indices and Research Areas.	
UNIT – 5	Synchro Phasor Measurement Units: Introduction, Phasor representation of sinusoids, a generic PMU, GPS, Phasor measurement systems, Communication options for PMUs, Functional requirements of PMUs and PDCs, Phasors for nominal frequency signals, types of	

	frequency excursions in power systems, DFT estimation at off nominal frequency with a nominal frequency clock.	
	Total	

Text Books:

1. John J.Grainger and William D.Stevenson, Jr. : Power System Analysis, McGraw-Hill, 1994, International Edition
2. Allen J.Wood and Bruce F.Wollenberg: Power Generation operation and control, John Wiley & Sons, 1984.
3. A.G.Phadka and J.S. Thorp, “Synchronized Phasor Measurements and Their Applications”, Springer, 2008

Reference Books:

1. R.N.Dhar : Computer Aided Power Systems Operation and Analysis, Tata McGraw Hill, 1982
2. L.P.Singh : Advanced Power System Analysis and Dynamics, Wiley Eastern Ltd. 1986
3. PrabhaKundur : Power System Stability and Control -, McGraw Hill, 1994
4. P.D.Wasserman: ‘Neural Computing: Theory and Practice’ Van Nostrand -Feinhold, New York.

COURSE CODE – R2511XXYY	ELECTRICAL DISTRIBUTION SYSTEMS AND AUTOMATION (Program Elective – 1 & 2)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Analyze distribution system planning, feeder design, and optimal substation location, integrating load modeling, classification, and the economic and technical implications of compensation and voltage control equipment.	4
CO2	Apply principles of protection, automation, and SCADA systems to design and implement coordinated distribution system operation—considering protection schemes, voltage regulation, and capacitor placement for improved efficiency and reliability.	3
CO3	Evaluate advanced distribution automation technologies, communication options, and data management systems, assessing their impact on steady-state and dynamic performance, system automation, and smart grid integration.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	3	2
CO2	1	2	3	3	3
CO3	2	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	General: Introduction to Distribution systems-Load modeling and characteristics, definition of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor-Relationship between the load factor and loss factor – Classification of loads (Residential, Commercial, Agricultural and Industrial) and their characteristics.	
UNIT – 2	Distribution Feeders: Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, and feeder-loading. Design practice of the secondary distribution system. Substations: Location of Substations, Rating of a Distribution Substation, service area with ‘n’ primary feeders. Benefits derived through optimal location of substations.	
UNIT – 3	Distribution System Protection: Over current Protective Devices, Objectives of distribution system protection, Coordination of protective devices, types of coordination, types of common faults in distribution systems and procedure for fault calculation.	
UNIT – 4	Capacitive compensation for power factor control: Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors, power factor correction, applications of capacitors, Economic justification, Procedure to determine the best capacitor location. Voltage control: Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation.	

UNIT – 5	Distribution Automation Functions: An overview of the role of computers in distribution system planning, Electrical system automation, MS functional scope, DMS functional scope functionality of DMS: Steady state and dynamic performance improvement, Geographic information systems: AM/FM functions and Database management, communication options, supervisory control and data acquisition: SCADA functions and system architecture, Synchrophasors and its application in power systems.	
	Total	

Text Books:

1. “Electric Power Distribution System Engineering “byTuran Gonen, Mc.Graw-Hill Book Company, 1986.
2. Distribution System Analysis and Automation, by Juan M. Gers, The Institution of Engineering and Technology, UK 2014.

Reference Books:

1. Electric Power Distribution-by A.S.Pabla, Tata McGraw-Hill Publishing Company, 4th edition, 1997.
2. Electrical Distribution V.Kamaraju-McGraw Hill
3. Handbook of Electrical Power Distribution – Gorti Ramamurthy-Universities press
4. For Communication aided Distribution Automation using IEC 61850: EPRI Tech. Report, “Guide to Implementing Distribution Automation Systems Using IEC 61850,” Dec. 2002.

Online:

1. ABB, Products – Distribution Control. [Online]. Available: <http://www.abb.com/product>
2. 6Schweitzer Engineering Laboratories, Inc., Products – Distribution Protection [Online]. Available: <http://www.selinc.com/>
3. GE Multilin, Products – Distribution Protection and Automation. [Online]. Available: <http://www.geindustrial.com/multilin/>

COURSE CODE – R2511XXYY	REACTIVE POWER COMPENSATION AND MANAGEMENT (Program Elective – 1 & 2)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Pre-requisite: Concepts of power systems.

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

		Knowledge Level (K)#
CO1	Analyze the objectives, specifications, and technical methods of reactive power compensation for loads and transmission lines, including steady-state and transient behaviors, and evaluate their effects on power factor correction, voltage regulation, and system efficiency.	4
CO2	Apply mathematical modeling and coordination techniques to optimize reactive power management and planning across power system elements, integrating compensation strategies for both distribution and user-side requirements.	3
CO3	Evaluate the impact of advanced reactive power compensation, including application in electric traction systems and arc furnaces, on system stability, power quality, and operational reliability under various operating conditions.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

UNIT	CONTENTS	Contact Hours
UNIT – 1	Load Compensation: Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads.	
UNIT-2	Steady State Reactive Power Control in Electric Transmission Systems: Introduction, Uncompensated line, Compensated lines, types of compensations, Passive shunt and series and dynamic shunt compensation.	
UNIT – 3	Reactive Power Compensation and Dynamic Performance of Transmission Systems: Introduction, Four Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers.	
UNIT – 4	Reactive Power Planning in Distribution Systems: Planning of Distribution Systems – Objectives in planning – Economics Planning capacitor placement – Retrofitting of capacitor banks. Reactive Power Planning-User Side Selection of Capacitors:	

	Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor their characteristics and Limitations.	
UNIT – 5	Reactive Power Management in Industries: Railway Electric Traction Systems: Nature of Railway Electric Load- Typical layout of electrical traction systems – distribution transformers in railways–Sources of Harmonics in railways. Industrial Arc Furnaces, Rolling Mills and Other Major Power Consumers: Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –Power factor of an arc furnace.	
	Total	

Text Books:

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982.(Unit- 1,2,3)
2. Reactive power Management by D.M.Tagare, Tata McGraw Hill, 2004. (Unit-4,5)

COURSE CODE – R2511XXYY	ELECTRIC VEHICLES (Program Elective – 1 & 2)	CATEGORY PC	L-T-P 3 -0-0	CREDITS 3
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Pre-requisite: Knowledge of Power Electronics and Electric Drives

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

		Knowledge Level (K)#
CO1	Explain the fundamentals, components, and types of electric vehicles, including conventional vs electric, hybrid architectures, and associated advantages and applications.	2
CO2	Apply the knowledge of power converters, electric traction motors, and battery management systems for designing and analyzing electric vehicle drive trains and control systems.	3
CO3	Analyze emerging Vehicle-to-Grid (V2G) and Grid-to-Vehicle (G2V) technologies, energy scenarios, EV charging schemes, and their implications on grid support and energy trading.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

	Total	
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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.

COURSE CODE – R2511XXYY	POWER ELECTRONIC CONVERTERS (Program Elective – 1 & 2)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Understand the characteristics and switching behaviour of modern power devices and corresponding gate driver circuits. Understand the operation of AC-DC converters, DC-DC converters, two-level inverters and various multilevel inverter configurations.	2
CO2	Apply various control strategies to improve input power quality and perform harmonic reduction in AC-DC conversion systems. Choose ratings of switching devices, L and C values to develop a DC-DC converter	3
CO3	Analyze and compare different PWM techniques for two-level and multi-level inverters to reduce harmonics.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

UNIT	CONTENTS	Contact Hours
UNIT– 1	Overview of Switching Devices: Power MOSFET, IGBT, GTO, GaN devices-static and dynamic characteristics, gate drive circuits for switching devices.	
UNIT– 2	AC-DC converters: Single phase fully controlled converters with RL load– Evaluation of input power factor and harmonic factor- Continuous and Discontinuous load current, Power factor improvements, Extinction angle control, symmetrical angle control, PWM control, Single-phase single stage boost power factor corrected rectifier. Three Phase AC-DC Converters, fully controlled converters feeding RL load with continuous and discontinuous load current, Evaluation of input power factor and harmonic factor	
UNIT– 3	DC-DC Converters: Buck converter, Boost converter, Buck-Boost converter, Forward converter, Full-bridge converter, Flyback converter, Choosing L and C values, device ratings for DC-DC converters	
UNIT– 4	PWM Inverters: Voltage control of single-phase inverters employing phase displacement Control, Bipolar PWM, Unipolar PWM. Three-phase Voltage source inverters: Six stepped VSI operation-Voltage Control of Three-Phase Inverters employing Sinusoidal PWM, Third Harmonic PWM, Space Vector Modulation- Comparison of PWM Techniques- Three	

	phase current source inverters.	
UNIT– 5	Multilevel Inverters: Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Cascaded H-bridge Multilevel Inverter, Principle of Operation, Features of Cascaded H-bridge Inverter, Fault tolerant operation of CHB Inverter PWM Multilevel Inverters: CHB Multilevel Inverter: Stair case modulation-SHE PWM- Phase shifted Multicarrier modulation-Level shifted PWM- Diode clamped Multilevel inverter: SHE PWM-Sinusoidal PWM- Space vector PWM	
	Total	

Text Books

1. Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M. Undeland, William P. Robbins, John Wiley & Sons, 2nd Edition, 2003.
2. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint- 2008.

Reference Books:

1. Power Electronics Semiconductor Switches – Ram Shaw, 1993.
2. Power Electronics, Daniel W. Hart – McGraw-Hill, 2011.
3. Power Electronics: essentials & Applications, L. Umanand, Wiley, 2009.
4. Fundamentals of power Electronics, Robert W. Erickson, Dragon Maksimovic, Springer, 2001.

M.Tech. I-Semester

COURSE CODE – R2511XXYY	POWER SYSTEM DYNAMICS AND STABILITY (Program Elective – 1 & 2)	CATEGORY PC	L-T-P 3 -0-0	CREDITS 3
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Analyze the dynamic behavior and stability limits of synchronous machines and power systems under steady-state and transient conditions using state-space models and eigenvalue approaches.	4
CO2	Apply numerical simulation methods such as Runge-Kutta and Modified Euler techniques for transient stability analysis and understand the effect of governors, excitation systems, and automatic voltage regulators on system stability.	3
CO3	Evaluate various excitation system designs, including rotating and static exciters, and their impact on power system stability and control under multi-machine operating conditions.	5

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

UNIT	CONTENTS	Contact Hours
UNIT – 1	System Dynamics: Synchronous machine model in state space from computer representation for excitation and governor system –modeling of loads and induction machines.	
UNIT – 2	Steady state stability: Steady state stability limit – Dynamics Stability limit – Dynamic stability analysis – State space representation of synchronous machine connected to infinite bus-time response – Stability by Eigen value approach.	
UNIT – 3	Digital Simulation of Transient Stability: Swing equation machine equations – Representation of loads – Alternate cycle solution method – Direct method of solution – Solution Techniques: Modified Euler method – RungeKutta method – Concept of multi machine stability.	
UNIT – 4	Effect of governor action and excite on power system stability effect of saturation, saliency & automatic voltage regulators on stability.	
UNIT – 5	Excitation Systems: Rotating Self-excited Exciter with direct acting Rheostatic type voltage regulator – Rotating main and Pilot Exciters with Indirect Acting Rheostatic Type Voltage Regulator – Rotating Main Exciter, Rotating Amplifier and Static Voltage Regulator – Static excitation scheme – Brushless excitation system.	
	Total	

Text Books:

1. Power System Stability by Kimbark Vol. I&II, III, Willey.
2. Power System control and stability by Anderson and Fund, IEEE Press.

Reference Books:

1. Power systems stability and control by PRABHA KUNDUR, TMH.
2. Computer Applications to Power Systems–Glenn.W.Stagg& Ahmed. H.El.Abiad, TMH.
3. Computer Applications to Power Systems – M.A.Pai, TMH.
4. Power Systems Analysis & Stability – S.S.Vadhera Khanna Publishers

M.Tech. I-Semester

COURSE CODE – R2511XXYY	EVOLUTIONARY ALGORITHMS IN POWER SYSTEMS (Program Elective – 1 & 2)	CATEGORY PC	L-T-P 3 -0-0	CREDITS 3
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Pre-requisite: Optimization Techniques and Power System Operation

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

		Knowledge Level (K)#
CO1	Understand and explain fundamentals of soft computing, optimization problems, and evolutionary algorithms for power system applications	2
CO2	Apply genetic algorithms, particle swarm, bat, artificial bee colony, harmony search, and TLBO techniques to optimize economic load dispatch and PI controller tuning.	3
CO3	Analyze multi-objective optimization concepts like Pareto optimality and implement NSGA-II for solving complex power system problems.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

UNIT	CONTENTS	Contact Hours
UNIT – 1	Fundamentals of Soft Computing Techniques Introduction to real world optimization problems-Properties of practical optimization problems-Mathematical formulation of single-objective and multi-objective optimization problems-Classification of optimization problems- Classification of conventional optimization methods – Steepest descent method-drawbacks of conventional optimization methods-Classification of computational intelligent techniques-Evolutionary algorithms- Single solution based and population based algorithms – Exploitation and exploration in population based algorithms – Advantages of Evolutionary algorithms over conventional optimization methods	
UNIT-2	Genetic Algorithm and Particle Swarm Optimization Genetic algorithms- Generalized framework -introduction to binary-coded GA -Real-coded GA: initialization of population- selection operator-crossover and mutation operators. PSO: Bird flocking and Fish Schooling –swarm initialization- swarm evaluation- velocity and position updation - control parameters – GA and PSO algorithms for Economic load dispatch and PI controller tuning.	
UNIT – 3	Artificial Bee Colony Algorithm and Bat optimization Algorithm Bat optimization algorithm-Echolocation of bats- Behavior of microbats-Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse Emission- Artificial bee colony (ABC) algorithms- Foraging	

	Behavior of Honey Bees-Initialization phase-Employee bee phase – Onlooker bee phase - Scout bee phase -Applications of Bat and ABC optimization algorithms for Economic load dispatch and PI controller tuning.	
UNIT – 4	Harmony search Algorithm (HSA) and Teacher learning based optimization Algorithm (TLBO) HSA: Initialize harmony memory- Improvise a new harmony from the harmony memory- Update harmony memory- Improved harmony search algorithm. Teacher learning based optimization Algorithm -Teacher phase-Learner phase-Demonstration of working of TLBO on unconstrained and constrained optimization problems- HSA and TLBO algorithms for Economic load dispatch and PI controller tuning.	
UNIT – 5	Multi Objective Optimization Introduction- Concept of Pareto optimality - Non-dominant sorting technique-Pareto fronts-best compromise solution-min-max method-NSGA-II algorithm and application to general two objective optimization problem.	
	Total	

Text Books

1. Xin-She Yang (editor), “Recent Advances in Swarm Intelligence and Evolutionary Computation”, Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb “Multi-Objective Optimization using Evolutionary Algorithms”, John Wiley & Sons, 2001.

Reference Books:

1. David Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Pearson Education, 2007.
2. Konstantinos E. Parsopoulos and Michael N. Vrahatis, “Particle Swarm Optimization and Intelligence: Advances and Applications”, Information science reference, IGI Global, , 2010.
3. Rao, R.V. (2016). Teaching-Learning-Based Optimization Algorithm. In: Teaching Learning Based Optimization Algorithm. Springer, Cham. https://doi.org/10.1007/978-3-319-22732-0_2

Reference Papers:

1. K. Nekooei, M. M. Farsangi, H. Nezamabadi-Pour and K. Y. Lee, "An Improved Multi-Objective Harmony Search for Optimal Placement of DGs in Distribution Systems," in IEEE Transactions on Smart Grid, vol. 4, no. 1, pp. 557-567, March 2013, doi: 10.1109/TSG.2012.2237420.
2. A New Metaheuristic Bat-Inspired Algorithm” by Xin-She Yang, Nature Inspired Cooperative Strategies for Optimization (NISCO 2010) (Eds. J. R. Gonzalez et al.), Studies in Computational Intelligence, Springer Berlin, 284, Springer, 65-74 (2010).

Online resources:

1. <https://nptel.ac.in/courses/103103164>
2. <https://nptel.ac.in/courses/112103301>

COURSE CODE – R2511XXYY	POWER SYSTEM SIMULATION LABORATORY – 1 (Laboratory – 1)	CATEGORY LB	L-T-P 0-1-2	CREDITS 1
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Apply computational methods and iterative techniques including Gauss-Seidel, Newton-Raphson, and decoupled methods for load flow analysis and fault calculations in power systems.	3
CO2	Analyze power system dynamic behaviors such as transient stability, load frequency control, and economic load dispatch using digital simulation tools and methods.	4
CO3	Understand the formation of bus admittance and impedance matrices, symmetrical and unsymmetrical fault analysis, and the role of controllers in maintaining system stability.	2

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

List of Experiments

S.No.	CONTENTS
1	Formation of Y- Bus by Direct-Inspection Method
2	Load Flow Solution Using Gauss-Siedel Method
3	Load Flow Solution Using Newton Raphson Method
4	Load Flow Solution Using Decoupled Method
5	Load Flow Solution Using Fast Decoupled Method
6	Formation of Z-Bus by Z-bus building algorithm
7	Symmetrical Fault analysis using Z-bus
8	Unsymmetrical Fault analysis using Z-bus
9	Economic Load Dispatch with & without transmission losses
10	Transient Stability Analysis Using Point By Point Method
11	Load Frequency Control of Single Area Control with and without controllers.
12	Load Frequency Control of Two Area Control system with and without controllers.

COURSE CODE – R2511XXYY	POWER SYSTEMS LABORATORY (Laboratory – 2)	CATEGORY LB	L-T-P 0-1-2	CREDITS 2
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Apply experimental methods to determine sequence impedances of alternators and transformers, and analyze transmission line parameters through practical fault analysis and measurements.	3
CO2	Analyze the performance of transmission lines including Ferranti effect, reactor compensation, and shunt compensation, and evaluate relay characteristics and protection schemes for generators and transformers.	4
CO3	Understand relay operation, protection principles, and equivalent circuit modeling of transformers used in power systems for effective fault detection and system reliability.	3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	3	2
CO2	2	1	3	3	2
CO3	1		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.	CONTENTS
1	Determination of Sequence Impedences of an Alternator by direct method.
2	Determination of Sequence impedances of an Alternator by fault Analysis.
3	Measurement of sequence impedance of a three phase transformer a) By application of sequence voltage. b) Using fault analysis.
4	Poly-phase connection on three single phase transformers and measurement of phase angle.
5	Determination of equivalent circuit of 3-winding Transformer.
6	Study of Ferranti effect in long transmission line.
7	Measurement of ABCD parameters on transmission line.
8	Performance of long transmission line without compensation.
9	To determine and verify the reactor compensation of transmission line.
10	Performance of long transmission line with shunt compensation.
11	To study the differential and percentage bias integrated relay operations.
12	Performance characteristics of Over current relay
13	To study the protection of generator and transformer.

COURSE CODE – R2511XXYY	TECHNICAL SEMINAR-I	CATEGORY	L-T-P 0-0-2	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 – R2511XXYY	ADVANCED POWER SYSTEMS PROTECTION (Program Core – 4)	CATEGORY PC	L-T-P 3 -1-0	CREDITS 4
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Pre-requisite: Knowledge on Power Generation Engineering, Power Transmission Engineering.

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

		Knowledge Level (K)#
CO1	Understand the principles, operating characteristics, and functioning of circuit breakers and electromagnetic relays, including distance relays like impedance, reactance, and Mho relays.	2
CO2	Apply protection schemes for generators and transformers including percentage differential protection, CT design, and numerical examples related to stator and rotor faults.	3
CO3	Analyze pilot relaying schemes, static relays, and microprocessor-based relays including numerical protection techniques such as Mann-Morrison and Discrete Fourier Transform methods for effective power system protection.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

UNIT	CONTENTS	Contact Hours
UNIT – 1	Circuit breakers Miniature Circuit Breaker (MCB)–Elementary principles of arc interruption– Re-striking phenomenon – RRRV- Vacuum and SF6 circuit breakers. Electromagnetic Relays Relay connection–Torque equation – Directional relays– Differential relays and percentage differential relays. Distance relays: Impedance, Reactance and Mho relays. Characteristics of distance relays and comparison.	
UNIT-2	Generator Protection Protection of generators against stator faults– Rotor faults and abnormal conditions– restricted earth fault Numerical examples. Transformer Protection Percentage differential protection– Design of CT's ratio–Numerical examples. Transformer protection: issues, differential protection of auto transformers, two-winding, three-winding transformers.	
UNIT – 3	PILOT Relaying schemes: Wire pilot protection: circulating current scheme – balanced voltage scheme – translay scheme – half wave comparison scheme - carrier current protection: phase comparison type – carrier aided distance protection – operational comparison of transfer trip	

	and blocking schemes – optical fibre channels.	
UNIT – 4	Static Relays classification and Tools: Components of static relays- Static over current (OC) relays – Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays.	
UNIT – 5	Microprocessor based relays and Numerical Protection: Over current relays – impedance relay – directional relay – reactance relay. Numerical Protection: Numerical relay – numerical relaying algorithms – mann-morrison technique – Differential equation technique and discrete fourier transform technique – numerical over current protection – numerical distance protection.	
	Total	

Text Books:

1. Power System Protection with Static Relays – by TSM Rao, TMH.
2. Power system protection & switchgear by Badri Ram & D N viswakarma, TMH.

Reference Books:

1. Protective Relaying Vol-II Warrington, Springer.
2. Art & Science of Protective Relaying - C R Mason, Willey.
3. Power System Stability Kimbark Vol-II, Willey.
4. Electrical Power System Protection –C.Christopoulos and A.Wright- Springer
5. Protection & Switchgear –Bhavesh Bhalaja, R.Pmaheshwari, Nilesh G.Chothani-Oxford publishers.
6. Distributed Generation (DG) Protection Overview Literature Review for ES 586b University of Western Ontario Andrew T. Moore, 250442203
<https://www.eng.uwo.ca/people/tsidhu/Documents/DG%20Protection%20V4.pdf>

M.Tech. II-Semester

COURSE CODE – R2511XXYY	SMART GRID TECHNOLOGIES (Program Core – 5)	CATEGORY PC	L-T-P 3 -1-0	CREDITS 4
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Analyze the evolution, enabling policies, and latest technological developments in smart grids, including their application to electric and hybrid vehicles.	2
CO2	Explain and design the roles of smart substations, feeder automation, GIS, and control architectures for microgrids in modern power systems.	3
CO3	Assess power quality, ICT advancements, and smart grid communications, evaluating their impact on operational efficiency and grid reliability.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	3	3
CO2	2	2	3	3	3
CO3	3	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 Grids: Evolution of the electric grid; concept and definitions of smart grids; need, functions, and features; opportunities and challenges; comparison between conventional and smart grids; concept of resilient and self-healing grids; current developments and international policies on smart grids; case study of a smart grid implementation.	
UNIT – 2	Smart Grid Technologies – Part I: Smart meters, real-time pricing, smart appliances, automatic meter reading (AMR), outage management systems (OMS), plug-in hybrid electric vehicles (PHEV) and vehicle-to-grid (V2G) concepts, smart sensors, home and building automation, phase-shifting transformers.	
UNIT – 3	Smart Grid Technologies – Part II: Smart substations and substation automation; feeder automation; Geographic Information Systems (GIS); Intelligent Electronic Devices (IEDs) for monitoring and protection; smart storage technologies – batteries, SMES, pumped hydro, compressed air energy storage; Phasor Measurement Units (PMUs) and Wide Area Measurement Systems (WAMS).	

UNIT – 4	Microgrids: Concept, need, and applications; formation and configuration of microgrids; operation in grid-connected and islanded modes; interconnection issues; protection, control, and energy management of microgrids.	
UNIT – 5	Power Quality for Smart Grids: Power quality and electromagnetic compatibility (EMC) in smart grids; power quality issues in grid-connected renewable energy sources; power quality conditioners; web-based monitoring systems; power quality audits. Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN).	
	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. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, AkihikoYokoyama, “Smart Grid: Technology and Applications”, Wiley.
2. Jean Claude Sabonnadière, NouredineHadjsaïd, “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. II-Semester

COURSE CODE – R2511XXYY	FLEXIBLE AC TRANSMISSION SYSTEMS (Program Core – 6)	CATEGORY PC	L-T-P 3 -1-0	CREDITS 4
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Understand the concepts, types, and benefits of FACTS devices, including voltage and current source converters, and their role in improving transmission system stability and power flow control.	2
CO2	Apply different static shunt and series compensation techniques using SVC, STATCOM, TCSC, and other FACTS controllers for enhancing transient stability, voltage regulation, and damping power oscillations.	3
CO3	Analyze the operation, control, and performance of advanced FACTS devices such as Unified Power Flow Controllers (UPFC) and Interline Power Flow Controllers (IPFC) for independent real and reactive power flow control.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

UNIT	CONTENTS	Contact Hours
UNIT – 1	Introduction: FACTS concepts, Transmission interconnections, power flow in an AC System, HVDC vs FACTS, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.	
UNIT – 2	Basic concept of voltage and current source converters, comparison of current source converters with voltage source converters. 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 - Characteristics and control schemes of SVC.	

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- power angle characteristics	
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	

Text Books:

1. “Understanding FACTS Devices” N.G.Hingorani and L.Guygi, IEEE Press. Indian Edition is available:--Standard Publications

Reference Books:

1. Sang.Y.Hand 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 – R2511XXYY	EHVAC & DC TRANSMISSION (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Course Outcomes: After the completion of the course the student should be able to:

		Knowledge Level (K)#
CO1	Explain the necessity, advantages, and challenges of EHV AC transmission systems, and analyze electric field distribution, voltage gradients, and corona effects on transmission performance.	
CO2	Evaluate the principles, components, and control strategies of HVDC transmission systems, including converter configurations, link control, and system operation.	
CO3	Analyze the generation and impact of harmonics in AC/DC systems and design appropriate filter circuits to ensure power quality and system stability.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

UNIT	CONTENTS	Contact Hours
UNIT - 1	Introduction of EHV AC transmission Necessity of EHV AC transmission – Advantages and problems– Power handling capacity and line losses– Mechanical considerations in line performance – Electrostatics – Field of sphere gap – Field of line charges and properties – Charge – potential relations for multi–conductors – Surface voltage gradient on conductors – Bundle spacing and bundle radius– Examples – Distribution of voltage gradient on sub conductors of bundle – Examples.	
UNIT - 2	Corona effects Power loss and audible noise (AN) – Corona loss formulae – Charge voltage diagram – Generation – Characteristics – Limits and measurements of AN – Relation between 1–phase and 3–phase AN levels – Examples – Radio interference (RI) – Corona pulses and their generation – Properties and limits – Frequency spectrum – Modes of propagation – Excitation function – Measurement of RI, RIV and excitation functions – Examples	
UNIT - 3	Basic Concepts of DC Transmission Economics & Terminal equipment of HVDC transmission systems: Types of HVDC Links – Apparatus required for HVDC Systems – Comparison of AC & DC transmission – Application of DC Transmission System – Planning &	

	Modern trends in DC transmission – Types of MTDC systems.	
UNIT - 4	Analysis of HVDC Converters and System Control Choice of Converter configuration – Analysis of Graetz circuit – Characteristics of 6 Pulse & 12 Pulse converters — Principal of DC Link Control – Converters Control Characteristics – Firing angle control –Constant Current and extinction angle control –Starting and stopping of DC link – Power Control.	
UNIT - 5	Harmonics and Filters Generation of Harmonics – Characteristics harmonics – Calculation of AC Harmonics – Non-Characteristics harmonics – Adverse effects of harmonics – Calculation of voltage & current harmonics – Effect of Pulse number on harmonics. Types of AC filters, Design of Single tuned filters – Design of High pass filters.	
	Total	

Text Books:

1. HVDC Power Transmission Systems: Technology and system Interactions – by K.R.Padiyar, New Age International (P) Limited, and Publishers.
2. Direct Current Transmission – by E.W.Kimbark, John Wiley & Sons.
3. EHVAC Transmission Engineering by R. D. Begamudre, New Age International (p) Ltd.

Reference Books:

1. EHVAC and HVDC Transmission Engineering and Practice – S.Rao.
2. Power Transmission by Direct Current – by E.Uhlmann, B.S.Publications
3. HVDC Transmission – J.Arrillaga.

M.Tech. II-Semester

COURSE CODE – R2511XXYY	AI APPLICATIONS IN POWER SYSTEMS (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Understand the fundamentals of Artificial Neural Networks (ANN), including neuron models, learning algorithms, and typical architectures, along with classical and fuzzy set theories.	2
CO2	Apply various ANN paradigms like backpropagation, radial basis function networks, and Kohonen maps, as well as fuzzy logic controllers for solving power system problems such as load forecasting and load flow studies.	3
CO3	Analyze the application of AI techniques in power system control, including single-area and two-area load frequency control, evaluating their effectiveness in improving system stability and performance.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

(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) – Humans and computers – Biological neural networks – ANN Terminology – Models of Artificial neuron – activation functions –typical architectures – biases and thresholds – learning strategy(supervised, unsupervised and reinforced) learning rules,perceptron training andclassification using Discrete and Continuous perceptron algorithms, ADALINE and MADLINE – linear separability and non-separability with examples.	
UNIT- 2	ANN Paradigms Generalized delta rule – Back Propagation algorithm- Radial Basis Function (RBF) network. Kohonen’s self-organizing feature map (KSOFM), Learning Vector Quantization (LVQ) – Functional Link Networks (FLN) – Bidirectional Associative Memory (BAM) – Hopfield Neural Network.	
UNIT- 3	Classical and Fuzzy Sets Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, 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 Load forecasting using back propagation algorithm –load flow studies using back propagation algorithm, single area and two area load frequency control using fuzzy logic.	
	Total	

Text Books:

1. Introduction to Artificial Neural Systems - Jacek M. Zuarda, Jaico Publishing House, 1997.
2. Fuzzy logic with Fuzzy Applications – T.J Ross – McGraw Hill Inc, 1997.

Reference Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by RajasekharanandPai – PHI Publication.
2. Introduction to Neural Networks using MATLAB 6.0 by S N Sivanandam,SSumathi,S N Deepa TMGH
3. Introduction to Fuzzy Logic using MATLAB by S N Sivanandam,SSumathi,S N Deepa Springer, 2007.

M.Tech. II-Semester

COURSE CODE – R2511XXYY	RESTRUCTURED POWER SYSTEMS (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Explain the concepts, benefits, entities, and global context of deregulation in the electric supply industry, including market structures and operations.	2
CO2	Analyze power system operation, transmission pricing, open access, congestion, and security management in a competitive market.	3
CO3	Evaluate ancillary services management and electric energy trading frameworks, including instruments, portfolio management, and green power trading.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

UNIT	CONTENTS	Contact Hours
UNIT – 1	Deregulation of The Electric Supply Industry Introduction, concept of Deregulation, Different entities in deregulated electricity markets; Independent System Operator (ISO), Market Operator; Background to Deregulation and the Current Situation Around the World; Benefits from a Competitive Electricity Market; After-Effects of Deregulation. Market Structure and Operation Objectives of Market operations; Electricity Market Models –Pool Company, Bilateral Contracts and Hybrid; Power Market Types – Energy Services, Ancillary Services and Transmission Markets; Forward and Real-Time Markets; Market Power.	
UNIT – 2	Power System Operation in Competitive Environment Introduction, Role of the Independent System Operator; Operational planning activities of ISO – in Pool and Bilateral Markets; Operational planning activities of a Genco – in Pool Markets, Bilateral Markets; Market participation issues; Unit Commitment in Deregulated Environment; Competitive Bidding.	
UNIT – 3	Transmission Open Access and Pricing Issues Introduction, Power Wheeling; Transmission Open Access; Cost components in transmission; Pricing of Power Transactions – Embedded	

	Cost Based and Incremental Cost Based Transmission Pricing. Security Management in Deregulated Environment; Congestion Management in Deregulation.	
UNIT – 4	Ancillary Services Management General description of some ancillary services; Ancillary Service Management in various countries; Check-List of Ancillary Services Recognized by Various markets; Reactive Power as an Ancillary service.	
UNIT – 5	Electric Energy Trading Introduction, Essence of Electric Energy Trading, Energy Trading Framework, Derivative Instruments of Energy Trading, Portfolio Management, Energy Trading Hubs, Brokers in Electricity Trading, Green Power Trading.	
	Total	

Text Books:

1. Operation of restructured power systems – K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, Springer (For Units – 1, 2, 3, and 4)
2. Market operations in electric power systems – M. Shahidehpour, H. Yamin and Z. Li, Wiley (For Units – 1 and 5)

Reference Books:

1. Power System Economics: Designing markets for electricity – S. Stoft, Wiley.
2. Loi Lei Lai, “Power System Restructuring and Deregulation”, 1st edition, John Wiley & Sons Ltd., 2012.

Online Learning Resources:

1. <https://nptel.ac.in/courses/108101005>

M.Tech. II-Semester

COURSE CODE – R2511XXYY	BATTERY MANAGEMENT SYSTEMS AND CHARGING STATIONS (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Explain different EV battery types, their nominal ratings, and key characteristics, and apply appropriate charging and balancing strategies to ensure safety, efficiency, and extended battery life.	2
CO2	Analyze and design battery management system (BMS) architecture, including components, communication protocols, and charging infrastructure integration for robust EV operation.	3
CO3	Evaluate battery modeling, diagnostics, and real-world operational challenges to enhance EV performance, reliability, and safety under diverse application conditions.	4

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	3	2
CO2	2	2	3	3	3
CO3	1	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	EV Batteries: Cell and battery fundamentals – nominal voltage, capacity, C-rate, energy and power relationships; series and parallel cell configurations. Lead–Acid Batteries: Basic operation, characteristics, life cycle, and maintenance. Nickel-Based Batteries: Ni-Cd and Ni-MH batteries – chemistry and applications. Sodium-Based Batteries: Na–S and Na–NiCl ₂ (Zebra) batteries. Lithium-Based Batteries: Li-ion and Li-polymer batteries – structure, chemistry, and characteristics.	
UNIT – 2	Battery Charging Strategies: Charging algorithms – CC, CV, CC–CV, MSCC, TSCC, CVCC–CV, and pulse charging methods for different chemistries (Lead–acid, NiMH, Li-ion); charging performance evaluation, termination techniques, and emerging fast-charging technologies. Battery Balancing Techniques: Sorting, overcharge balancing, passive and active balancing methods.	
UNIT – 3	Charging Infrastructure: Overview of domestic and public charging infrastructure; classification – normal, fast, occasional, and battery-swapping stations; AC/DC chargers and communication standards (IEC 61851, ISO 15118); grid interaction, move-and-charge zones, and safety	

	protocols.	
UNIT – 4	Battery Management System (BMS): BMS architecture and design requirements; sensing (voltage, current, temperature, isolation); contactor and thermal control; protection and diagnostics; SOC, SOH, SOE estimation; communication interfaces (CAN, LIN); charger control and data logging.	
UNIT – 5	Battery Modeling and Simulation: Overview of modeling approaches; equivalent circuit and electrochemical models; Li-ion and NiCd battery simulation; model parameterization and validation; diagnostic methods for degradation analysis; case studies of model-based BMS implementation.	
	Total	

Text Books

1. James Larminie and John Lowry, Electric Vehicle Technology Explained, Oxford University Press. (Unit–1)
2. K. T. Chau, Energy Systems for Electric and Hybrid Vehicles, IET Publications, 1st Edition, 2016. (Unit–2)

Reference Books:

1. C. C. Chan and K. T. Chau, Modern Electric Vehicle Technology, Oxford University Press, New York, 2001. (Unit–3)
2. Gregory L. Plett, Battery Management Systems, Vol. II: Equivalent Circuits and Methods, Artech House Publishers, 1st Edition, 2016. (Unit–4)
3. Henk Jan Bergveld, Wanda S. Kruijt, and Peter H. L. Notten, Battery Management Systems: Design by Modelling, Springer Science & Business Media, 2002. (Unit–5)

M.Tech. II-Semester

COURSE CODE – R2511XXYY	DATA DRIVEN POWER SYSTEMS (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Identify and characterize different types of data used in power system operation and apply preprocessing and feature engineering techniques to prepare datasets.	
CO2	Develop and simulate data-driven models for forecasting and anomaly detection in power systems, integrating physics-based and machine learning approaches for hybrid solutions.	
CO3	Analyze case studies to evaluate the effectiveness of AI/ML methods in real-world power system control scenarios, improving operational reliability and efficiency.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

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

UNIT	CONTENTS	Contact Hours
UNIT – 1	Introduction to Data-Driven Power Systems: Overview of conventional vs data-driven paradigms; data sources in power systems (SCADA, PMU, AMI, weather, market data); data acquisition, storage, and quality issues; applications of data analytics in generation, transmission, and distribution systems.	
UNIT – 2	Statistical Analysis and Data Preprocessing: Probability distributions, hypothesis testing, time series analysis, autocorrelation, and stationarity; data cleaning, normalization, feature extraction and selection; handling missing data and outliers; dimensionality reduction techniques (PCA, t-SNE).	
UNIT – 3	Machine Learning Techniques for Power Systems: Supervised learning (regression, classification), unsupervised learning (clustering, anomaly detection), and ensemble methods; neural networks and deep learning basics; evaluation metrics and cross-validation.	

UNIT – 4	Applications of Data-Driven Models: Load, renewable, and price forecasting; fault detection and predictive maintenance; power quality event classification; state estimation using data-driven and hybrid approaches; cyber-attack detection in smart grids.	
UNIT – 5	Emerging Trends and Case Studies: Reinforcement learning in power system operation; physics-informed machine learning (PIML); digital twins for grid management; data privacy and cybersecurity; case studies of AI/ML deployment in grid operations and microgrids.	
	Total	

Text Books:

1. S. L. Brunton and J. N. Kutz, Data-Driven Science and Engineering: Machine Learning, Dynamical Systems, and Control, Cambridge University Press, 2019.
2. M. Kezunovic, Z. Obradovic, S. Stankovic, Data Analytics Applications in Power Systems, Springer, 2020.

Reference Books:

1. James Catlett, Data Analytics for Power Systems, CRC Press, 2021.
2. A. Abur and A. G. Expósito, Power System State Estimation: Theory and Implementation, CRC Press.
3. IEEE Transactions on Smart Grid and IEEE Transactions on Power Systems – Special Issues on Data-Driven Applications in Power Systems.

M.Tech. II-Semester

COURSE CODE – R2511XXYY	ENERGY STORAGE TECHNOLOGIES (Program Elective – 3 & 4)	CATEGORY PE	L-T-P 3 -0-0	CREDITS 3
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Explain the principles, characteristics, and classifications of key energy storage technologies for power systems and electric mobility.	
CO2	Model, simulate, and analyze the performance of diverse energy storage systems integrated in smart grids, cities, and electric vehicles.	
CO3	Assess and recommend suitable energy storage solutions for grid and mobility applications, factoring in technical performance and economic feasibility.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	3	2
CO2	2	2	3	3	3
CO3	2	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 Energy Storage Systems: Importance and role of energy storage in modern power systems; classification and comparison of storage technologies; grid applications and ancillary services; economic aspects – energy costs, load analysis, and demand response; role of storage in uncertainty management of renewable energy systems and microgrids; mathematical modeling of energy storage systems.	
UNIT – 2	Battery Energy Storage Systems (BESS): Overview of major battery technologies – lead-acid, lithium-ion, flow batteries, and emerging chemistries; battery design considerations, life-cycle analysis, and performance parameters; modeling and simulation of BESS; environmental and reliability aspects; applications in electric vehicles and stationary storage.	
UNIT – 3	High-Power Energy Storage Devices: Ultra-capacitors: Operating principles, charge–discharge characteristics, and applications in renewable integration and electric mobility; emerging materials and technologies. Superconducting Magnetic Energy Storage (SMES): Theory, operation, and design considerations; large-scale SMES applications for utility power systems and research trends.	
UNIT – 4	Mechanical and Hybrid Energy Storage: Compressed Air Energy Storage (CAES): Concepts, operation, modeling, and efficiency; siting,	

	cost, and environmental considerations; role in bulk storage and carbon capture. Mobile and Stationary Storage: Comparison of mobile vs. fixed systems; vehicle-to-grid (V2G) applications; energy management using time-of-day metering and scheduling for peak shaving and grid support.	
UNIT – 5	Rotational and Electrochemical Hybrid Storage: Flywheel Energy Storage (FES): Principles, energy equations, efficiency, and self-discharge; design and selection for UPS, transportation, and grid stability; safety and maintenance considerations. Fuel Cell-Based Storage: Fuel cell technologies and hybrid energy systems; modeling and applications for stationary and transportation systems.	
	Total	

Text Books:

1. Andrei Ter-Gazarian, *Energy Storage for Power Systems*, Institution of Engineering and Technology (IET), 3rd Edition, 2020.
2. Ali Keyhani, Mohammad N. Marwali, and Min Dai, *Integration and Control of Renewable Energy in Electric Power Systems*, John Wiley & Sons, 2nd Edition, 2010.

Reference Books:

1. S. Chowdhury, S. P. Chowdhury, P. Crossley, *Microgrids and Active Distribution Networks*, IET Power Electronics Series, 2012.
2. Zechun Hu, *Energy Storage for Power System Planning and Operation*, IEEE Press, 2020, 1st Edition.
3. Slobodan Petrovic, Peter Kurzweil, Jürgen Garche, *Electrochemical Energy Storage: Batteries, Fuel Cells, and Hydrogen Technologies*, McGraw Hill, 2022, 1st Edition.

Other Suggested Readings:

1. <https://nptel.ac.in/courses/112106318>

COURSE CODE – R2511XXYY	POWER SYSTEM SIMULATION LABORATORY – II (Laboratory – 3)	CATEGORY LB	L-T-P 0-0-3	CREDITS 1.5
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Simulate and analyze power system stability under various conditions using numerical integration techniques including Euler, Runge-Kutta, and state-space methods with and without stabilizers.	
CO2	Develop and implement optimal operation and control algorithms such as Newton’s method for Optimal Power Flow, dynamic programming for Unit Commitment, and Genetic Algorithms for optimization-based system planning.	
CO3	Conduct advanced power system studies — including load flow, contingency analysis, state estimation, and power quality improvement using FACTS devices like D-STATCOM — to enhance system reliability and performance.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

(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

S.No.	CONTENTS
1	Multi Machine Transient stability using modified Euler’s method.
2	Multi Machine Transient stability using R-K 2 nd order method.
3	Optimal Power Flow using Newton’s method.
4	Unit Commitment using dynamic programming.
5	Optimal Power Flow using Genetic Algorithm.
6	Distribution system load flow solution using Forward-Backward sweep Method.
7	Contingency analysis of a Power System
8	State estimation of a power system using Weighted Least Squares Error Method
9	Stability Analysis of SMIB using State space approach without PSS controller
10	Stability Analysis of SMIB using State space approach with PSS controller
11	Power Quality improvement using D-STATCOM

M.Tech. II-Semester

COURSE CODE – R2511XXYY	RENEWABLE ENERGY SYSTEMS LABORATORY (Laboratory – 4)	CATEGORY LB	L-T-P 0-0-3	CREDITS 1.5
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Course Outcomes: At the end of the course, student will be able to

		Knowledge Level (K)#
CO1	Model and simulate solar photovoltaic systems under varying environmental conditions, analyzing I–V and P–V characteristics, shading effects, tilt angle, diode functions, and converter interfacing for maximum power extraction.	
CO2	Evaluate and control energy conversion processes in wind and hybrid (solar-wind-hydel) systems through parameter estimation, performance analysis, and integration using MATLAB/Simulink tools.	
CO3	Design and implement intelligent control, power conditioning, and energy management techniques—including MPPT, D-STATCOM, and UPS system simulations—for improving renewable system stability, quality, and reliability.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

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

(Please fill the above with Levels of Correlation, viz., L, M, H)

Any 10 of the following experiments are to be conducted.

S.NO	CONTENTS	Contact Hours
Software Based List of Experiments:		
1.	Simulate the Mathematical Model of a PV cell using Single Diode model and Two Diode model equivalent circuits.	
2.	Simulate the performance curves (I-V & P-V) for PV modules connect in series & parallel and their variation with temperature and irradiation.	
3.	Simulate the performance curves (I-V & P-V) for PV array connect in series & parallel and their variation with temperature and irradiation.	
4.	Simulate the performance curves (I-V & P-V) for the effect of varying the series resistance on the fill factor of the PV cell.	
5.	Analyze the effect of partial shading condition of a PV module.	
6.	Simulate the Buck-Boost Converter with Closed Loop control.	
7.	Simulate the Maximum Power Point tracking of PV module using INC Algorithm.	
8.	Simulate the Maximum Power Point tracking of PV module using P & O Algorithm.	
9.	Simulate the Wind Power Plant model.	
10.	Simulation study on Hybrid (Solar-Wind) Power System	
11.	Simulation study on Hydel Power	
12.	Simulate the Uninterrupted Power Supply model.	

13.	Simulation Study on Intelligent Controllers for Hybrid Systems	
14.	Single PV module I-V and P-V characteristics with radiation and temperature changing effect.	
15.	I-V and P-V characteristics with series and parallel combination of modules.	
16.	Effect of shading on PV Module.	
17.	Effect of tilt angle on PV Module.	
18.	Demonstration of bypass and blocking diode on a PV Module.	
19.	Evaluation of cut-in speed of wind turbine.	
20.	Evaluation of Tip Speed Ratio (TSR) at different wind speeds.	
21.	Evaluation of Coefficient of performance of wind turbine.	
22.	Characteristics of turbine (power variation) with wind speed.	
23.	Power curve of turbine with respect to the rotational speed of rotor at fix wind speeds.	
24.	Power analysis at turbine output with AC load for a Wind Energy System.	

M.Tech. II-Semester

COURSE CODE – R2511XXYY	TECHNICAL SEMINAR-II	CATEGORY	L-T-P 0-0-2	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 – R2511XXYY	RESEARCH METHODOLOGY AND IPR	CATEGORY	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)