M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

SRINIVASA INSTITUTE OF TECHNOLOGY & SCIENCE

(AUTONOMOUS)

Approved by AICTE, New Delhi – Affiliated to JNTUA, Ananthapuramu

Accredited by NAAC with 'A' Grade

Chennai-Hyderabad Bypass Road, Ukkayapalli, Kadapa-516002

M.TECH. IN ELECTRICAL POWER SYSTEMS / POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

(Applicable from the academic year 2025-26 onwards)

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SEMESTER – I

S. No.	Course codes	Course Name	Category	Hours per week			Credits
				L	T	P	
1.	25MEP101	Advanced Power System Protection	PC	3	0	0	3
2.	25MEP102	Power System Security and State Estimation	PC	3	0	0	3
3.	25MEP103-a 25MEP103-b 25MEP103-c	**Program Elective – I** Energy Auditing and Management Modelling and Analysis of HVDC Systems Power System Optimization	PE	3	0	0	3
4.	25MEP104-a 25MEP104-b 25MEP104-c	**Program Elective – II** Solar & Wind Energy Conversion Systems Smart Grid Technologies E-Mobility	PE	3	0	0	3
5.	25MEP106	Power System Analysis and Protection Lab	PC	0	0	4	2
6.	25MEP107	Power Systems Simulation Lab	PC	0	0	4	2
7.	25MRM101	Research Methodology and IPR	**MC**	**2**	**0**	**0**	**2**
8.	25MEP105	**Skill Enhancement Course** AI Techniques in Electrical Engineering	SE	2	0	0	2
9.	25MAC101a 25MAC101b 25MAC101c	**Audit Course – I** English for Research Paper Writing Disaster Management Essence of Indian Traditional Knowledge	AC	2	0	0	0
Total							**20**

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SEMESTER – II

S.No.	Course codes	Course Name	Category	Hours per			Credits
				L	T	P	
1.	25MEP201	Power System Stability and Control	PC	3	0	0	3
2.	25MEP202	FACTS Controllers	PC	3	0	0	3
3.	25MEP203-a 25MEP203-b 25MEP203-c	**Program Elective – III** Reactive power Compensation & Management Modern Control Theory Evolutionary Algorithms Applications in Power Engineering	PE	3	0	0	3
4.	25MEP204-a 25MEP204-b 25MEP204-c	**Program Elective – IV** Power Quality EV Charging Infrastructure & Technology EHVAC Transmission systems	PE	3	0	0	3
5.	25MEP205	Renewable Energy Sources Lab	PC	0	0	4	2
6.	25MEP206	FACTS Devices Simulation Lab	PC	0	0	4	2
7.	25BSH101	**Quantum Technologies And Applications**	MC	2	0	0	2
8.	25MEP207	**Comprehensive Viva Voce**	PC	0	0	0	2
9.	25MAC201a 25MAC201b 25MAC201c	**Audit Course – II**	AC	2	0	0	0
Total							**20**

****Students have to undergo an Industry Internship after I Year II Semester for a duration of 6 to 8 weeks**

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SEMSTER – III

S.No.	Course codes	Course Name	Category	Hours per			Credits
				L	T	P	
1.		**Program Elective – V** Restructured Power Systems Machine Learning Applications in Power Engineering Distributed Generation and Micro grid Control	PE	3	0	0	3
2.		**Open Elective-I**	OE	3	0	0	3
3.		**Dissertation Phase – I**	PR	0	0	20	10
4.		**Industry Internship**		0	0	0	2
5.		**Co- Curricular Activities**		0	0	0	1
Total							**19**

Open Elective-I

1.PHOTOVOLTAIC SYSTEMS

SEMESTER – IV

S.No.	Corse codes	Course Name	Category	Hours per			Credits
				L	T	P	
1.		**Dissertation Phase – II**	PR	0	0	32	16
Total							**16**

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Course Code	ADVANCED POWER SYSTEM PROTECTION	L	T	P	C
25MEP101		3	0	0	3
	Semester	**I**			

Course Objectives: To make the student

- To know construction of static relays, the operation of microprocessor based protective relays and Artificial Intelligence based numerical protection.
- To understand the operation of amplitude and phase comparators.
- To comprehend the concepts of Static over current, static differential and static distance relays.
- To understand multi-input comparators and concept of power swings on the distance relays.

Course Outcomes (CO):
Student will be able to

- Understand the construction of static relay and identify the advantages of static relay over electromagnetic relay and analyze the importance of reliability in various fields. L2
- Explore the operation of rectifier bridge comparators, instantaneous comparators, phase comparators, multi-input comparators, static differential and distance relays.L2
- Analyse over current relays, microprocessor based relays and also power swings on distance relays. L4
- Apply the concept of Artificial Intelligence in power system protection. L3

UNIT – I	**STATIC RELAYS & COMPARATORS**	Lecture Hrs: 8

Introduction to Static relays – Basic construction of Static relays – Level detectors – Replica Impedance– Mixing circuits– General equation for two input Phase and Amplitude Comparators – Duality between Amplitude and Phase Comparator.

Comparators: Types of Amplitude Comparators and Phase Comparators, Multi –Input Comparators: Conic section characteristics Three input amplitude comparator – Hybrid comparator – Switched distance schemes – Polyphase distance schemes– Phase fault scheme – Three phase scheme – Combined and ground fault scheme.

UNIT - II	**STATIC OVER CURRENT AND DIFFERENTIAL RELAYS**	Lecture Hrs:9

Introduction– Instantaneous over current relay – Time over current relays – Definite time and Inverse definite time over current relays– Directional over current relays – Static Differential Relays– Analysis of static differential relays– Static relay schemes– Dual bias transformer differential protection – Harmonic restraint relay.

UNIT - III	**STATIC DISTANCE RELAYS AND POWER SWINGS**	Lecture Hrs: 9

Static Distance Relays: Static Impedance – Reactance – MHO and Angle Impedance relay Sampling comparator – Realization of reactance and MHO relay using a sampling comparator.
Power Swings: Effect of power swings on the performance of Distance relays– Power swing analysis – Principle of out of step tripping and blocking relays – Effect of line length and source impedance on distance relays.

UNIT - IV	**MICROPROCESSOR BASED PROTECTIVE RELAYS**	Lecture Hrs: 12

Over current relays – Impedance relays – Directional relay – Reactance relay (Block diagram and flow chart approach only). Generalized mathematical expression for Distance relays– Measurement of R and X – MHO and offset MHO relays – Realization of MHO characteristics – Realization of Offset MHO characteristics (Block diagram and flow chart approach only) – Quadrilateral Relay –Basic principle of Digital computer relaying.

UNIT - V	**ARTIFICIAL INTELLIGENCE BASED NUMERICAL PROTECTION**	Lecture Hrs: 10

Application of Artificial Intelligence to Power System Protection – Application of ANN to Overcurrent Protection – Application of ANN to Transmission Line Protection – Neural Network Based Directional Relay – ANN Modular Approach for Fault Detection, Classification and Location – Wavelet Fuzzy Combined Approach for Fault Classification – Application of ANN to Power Transformer – Power Transformer Protection Based on Neural Network and Fuzzy Logic – Power Transformer Protection Based Upon Combined Wavelet Transform and Neural Network – Application of ANN to Generator Protection.

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Textbooks:

1. T.S. Madhava Rao, Power system Protection static relay, Tata McGrawHill Publishing Company limited, 2nd Edition, 2017.
2. Badri Ram and D.N. Vishwakarma, Power system Protection and Switchgear, Tata McGraw Hill Publication Company limited, 2nd Edition, 2013.

Reference Books:

1. Bhavesh Bhalja, R. P. Maheshwari, N. G. Chothani, Protection and Switchgear, Oxford University Press, 2nd Edition, New Delhi, India, 2018.
2. Oza, B. A., N. C. Nair, R. P. Mehta, et al., Power System Protection & Switchgear, Tata McGraw Hill, New Delhi, 1st Edition, 2011.

Online Learning Resources:

1. https://nptel.ac.in/courses/108105167
2. http://www.digimat.in/nptel/courses/video/108107167/L03.html

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Course Code	POWER SYSTEM SECURITY AND STATE ESTIMATION	L	T	P	C
25MEP102		3	0	0	3
	Semester	I			

Course Objectives: To make the student

- Understand the basic concepts of network matrices, power flow methods, state estimation, and applications of power system state estimation and structure of deregulated power system.
- Analyze about admittance/impedance matrices, factors influencing power system security, network problems and power wheeling transactions.
- Implement the methods for determining the bus matrices, optimal ordering, DC power flow, AC power flow, estimating a value and Available Transfer Capability (ATC).
- Develop the algorithm for orthogonal matrix, method to identify network problems and congestion management methods and electricity sector structure.

Course Outcomes (CO): Student will be able to

- Understand the concepts of network matrices, power flow methods, contingency analysis, state estimation, and need and conditions for deregulation. L2
- Analyze the bus admittance/impedance matrices methods, power system security, sensitivity factors, state estimation and electricity structure model. L4
- Apply the methods for evaluating the bus matrices, sparsity, DC power flow, AC power flow, estimating a value and Available Transfer Capability (ATC). L3
- Develop the methods for state estimation, method to identify network problems and methods for congestion management. L5

UNIT - I	POWER SYSTEM NETWORK MATRICES	Lecture Hrs: 10

Formation of bus admittance matrices by direct inspection method and singular transformation method – Algorithm for formation of Bus impedance matrix: addition of a branch and addition of a link, removal element in Bus impedance matrix– Sparsity programming and Optimal Ordering – Numerical problems – ∏-representation of off-nominal tap transformers.

UNIT - II	POWER SYSTEM SECURITY-I	Lecture Hrs: 9

Review of power flow methods (qualitative treatment only)– DC power flow method- Introduction to power system security – Factors influencing power system security.

UNIT - III	POWER SYSTEM SECURITY-II	Lecture Hrs: 10

Introduction to contingency analysis – Contingency analysis: Detection of Network problems, linear sensitivity factors –AC power flow methods– Contingency selection.

UNIT - IV	STATE ESTIMATION IN POWER SYSTEM	Lecture Hrs: 10

Power system state estimation – SCADA –EMS center, Methods of state estimation – Method of least squares, Orthogonal matrix–Properties– Givens rotation–Orthogonal decomposition–Bad data detection, Pseudo measurements and applications of power system state estimation – Simple problems.

UNIT - V	SECURITY IN DEREGULATED ENVIRONMENT	Lecture Hrs: 9

Need and conditions for deregulation–Electricity sector structure model – Power wheeling transactions – Congestion management methods– Available Transfer Capability (ATC) – System security in deregulation.

Textbooks:

1. Allen J. Wood and Wollenberg B.F., Power Generation Operation and control, John Wiley & Sons, 3rd edition, 2013.
2. P. Venkatesh, B.V. Manikandan, S. Charles Raja and A. Srinivasan, Electrical power systems analysis, security, and deregulation, PHI learning private limited, Delhi, 1st edition 2014.

Reference Books:

1. Nagrath I.J. and Kothari D.P., Modern Power System Analysis, TMH, New Delhi, 3rd Edition, 2004.
2. John J. Grainger and William D. Stevenson, Power System Analysis, Tata McGraw-Hill, 1st edition, 2003.

Online Learning Resources:

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1. https://nptel.ac.in/content/storage2/courses/108106022/LECTURE%205.pdf
2. https://nptel.ac.in/content/storage2/courses/108101040/download/Lec-26.pdf

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COURSE STRUCTURE & SYLLABI

Course Code	ENERGY AUDITING AND MANAGEMENT	L	T	P	C
25MEP103a	(PE-I)	3	0	0	3
	Semester	I			

Course Objectives: To make the student

- To understand the current energy scenario and importance of energy conservation.
- To acquire the knowledge about different energy efficient devices.
- To measure thermal efficiency and other renewable resources.
- To design suitable energy monitoring system to analyze and optimize the energy consumption in an electrical system.

Course Outcomes (CO): Student will be able to

- Understand the current energy scenario and importance of energy conservation. L2
- Acquire the knowledge about different energy efficient devices. L2
- Measure efficiency in renewable energy resources. L3
- Identify the equipment and areas of a system where energy conservation and Audit is necessary. L3

UNIT - I	ENERGY AUDIT AND DEMAND SIDE MANAGEMENT (DSM) IN POWER UTILITIES	Lecture Hrs: 10

Energy Scenario & Conservation -Demand Forecasting Techniques- Integrated Optimal Strategy for Reduction of T&D Losses - DSM Techniques and Methodologies- Loss Reduction in Primary and Secondary Distribution system and capacitors - Energy Management — Role of Energy Managers – Energy Audit-Metering.
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UNIT - II	ENERGY AUDIT	Lecture Hrs: 9

Energy audit concepts - Basic elements and measurements - Mass and energy balances - Scope of energy auditing in industries - Evaluation of energy conserving opportunities and environmental management - Preparation and presentation of energy audit reports - case studies and potential energy savings.

UNIT - III	INSTRUMENTATION	Lecture Hrs: 10

General Audit Instrumentation –Measuring building losses – Applications of IR thermo graphy – Measurement of electrical system performance – Measurement of heating, ventilation, air conditioning system performance – Measurement of combustion systems.

UNIT - IV	ENERGY CONSERVATION	Lecture Hrs:10

Energy conservation in HVAC systems and thermal power plants, Solar systems, Fan and Lighting Systems - Different light sources and luminous efficiency

UNIT - V	ECONOMIC EVALUATION OF ENERGY CONSERVATION	Lecture Hrs:9

Energy conservation in electrical devices and systems - Economic evaluation of energy conservation measures - Electric motors and transformers - Inverters and UPS - Voltage stabilizers.

Textbooks:

1. Frank kreith and D. Yogi goswamy/ Editors, "Energy Management and conservation handbook". NewYork,2019.
2. WC Turner: Energy Management Handbook, Seventh Edition, (Fairmont Press Inc., 2015)
3. YP Abbi and Shashank Jain: Handbook on Energy Audit and Environment Management, (TERIPress, 2006)

Reference Books:

1. Albert Thumann, and William J. Younger, "Handbook of Energy Audits", Marcel Dekker, Inc., Newyork, 6th edition, 2003.
2. D.A.Reay, Industrial Energy Conservation-Pergamon Press, 1980.
3. T.L.Boten, LiptakB.G.,(Ed)Instrument Engineers Handbook, Chinton Book Company, 2004.

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4. Hodge B.K, Analysis and Design of Energy Systems, Prentice Hall, 2002.
5. Larry C.Witte, Schmidt & Brown, Industrial energy management and utilization. Hemisphere publishing, Co.NewYork,1988.

Online Learning Resources:

1. https://onlinecourses.swayam2.ac.in/nou23_es05/preview
2. https://onlinecourses.nptel.ac.in/noc25_ar10/preview

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Course Code	MODELLING AND ANALYSIS OF HVDC SYSTEMS (PE-I)	L	T	P	C
25MEP103b		3	0	0	3
	Semester	I			

Course Objectives: To make the student

- To understand the concept, planning of DC power transmission.
- To analyze HVDC converters, Transient and Dynamic Stability.
- To apply modeling of power flow analysis.
- To design digital dynamic simulation of converters and DC systems.

Course Outcomes (CO): Student will be able to

- To identify the electrical requirements for HVDC lines. L3
- Analyze the different modes of operation for six pulse & twelve pulse converter unit in the context of HVDC system. L4
- Apply the knowledge of HVDC transmission in Power networks. L3
- Determine the appropriate HVDC transmission line parameters under different physical conditions. L2

UNIT – I	HVDC CONVERTERS AND SYSTEM CONTROL	Lecture Hrs: 10

Analysis of HVDC Converters: Pulse number – choice of converter configuration – simplified analysis of Graetz circuit – converter bridge characteristics. Converter and HVDC system control: Principles of DC link control – converter control characteristics – system control hierarchy – firing angle control – current and extinction angle control – starting and stopping of DC link power control.

UNIT – II	MODELING FOR POWER FLOW ANALYSIS OF AC/DC SYSTEMS	Lecture Hrs: 9

Modeling of HVDC Components: HVDC Converter model - Converter control - Modeling of DC network - Modeling of AC Network.

Power flow analysis in AC/DC systems: Modeling of DC links –Multi terminal DC links- Solution of DC load flow –per unit system for DC qualities – Solution of AC/DC power flow.

UNIT - III	TRANSIENT AND DYNAMIC STABILITY ANALYSIS	Lecture Hrs: 10

Transient stability Analysis – Converter model – Converter control models – DC network models – solution methodology – Direct methods for stability Evaluation.

Dynamic Stability and power modulation - Power modulation for damping low frequency oscillations – Basic principles – practical consideration in the application of power modulation controllers – Gamma or reactive power modulation – power modulation in MTDC system – voltage stability in AC/DC system.

UNIT – IV	HARMONIC AND TORSIONAL INTERACTIONS	Lecture Hrs: 10

Harmonic and Torsional Interactions: Harmonic Interactions - Torsion Interactions – Torsional interactions with in HVDC systems – counter measures to torsion interactions with DC systems.

Simulation of HVDC systems: System simulation – philosophy & Tools – HVDC system simulation – modeling of HVDC systems Digital dynamic simulation.

UNIT – V	MODELING OF HVDC SYSTEMS	Lecture Hrs: 9

Digital dynamic simulation of converters and DC systems: Valve model, Gate pulse generation – generation of control voltage – transformer model – converter model – transient simulation of DC and AC systems. HVDC Breakers, Monopolar Operation.

Textbooks:

1. K.R. Padiyar, HVDC Power Transmission Systems – Technology & System Interactions, New Age International Publishers, 3rd Edition, 2017
2. S Kamakshaiah and V Kamaraju, HVDC Transmission, Tata Mc Graw Hill, New Delhi, 2nd Edition, 2021.

Reference Books:

1. E.W. Kimbark, Direct current transmission, Wiely Inter Science – New York, 1st Edition, 1971
2. J. Arillaga, HVDC Transmission, Peter Peregrinus Ltd., London UK 2nd Edition, 1998
3. E. Uhlman, Power transmission by direct current, Springer Verlag, Berlin Helberg, 1st Edition, 1985

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Online Learning Resources:
1. https://www.youtube.com/watch?v=yP7OACmLP48

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Course Code	POWER SYSTEM OPTIMIZATION	L	T	P	C
25MEP103c	(PE-I)	3	0	0	3
	Semester	I			

Course Objectives: To make the student

- Understand the fundamental concepts of Optimization Techniques.
- Analyze the importance of optimizations in real life scenarios.
- Apply the concepts of various classical and modern methods for constrained and unconstrained problems in both single and multivariable.
- Design the algorithms for different optimizations techniques

Course Outcomes (CO): Student will be able to

- Understand the concept of optimality criteria for various type of optimization problems. L2
- Analyze the concept of different optimization techniques in real world applications. L4
- Solve various constrained and unconstrained problems in single variable as well as multivariable. L3
- Design the methods of optimization for real life situation. L5

UNIT – I	CONVENTIONAL OPTIMIZATION TECHNIQUES	Lecture Hrs: 10

Concepts & Terms related to Optimization -Quadratic optimization problem - Karush - Kuhn - Tucker (KKT) necessary and sufficient conditions for quadratic programming problem- Interior point method for convex optimization - linear programming.

UNIT – II	FUNDAMENTALS OF PARTICLE SWARM OPTIMIZATION (PSO) TECHNIQUE	Lecture Hrs: 9

Background of PSO – Original PSO – Variation of PSO – Discrete PSO – PSO for MINLPs – Constriction Factor Approach (CFA) – Hybrid PSO (HPSO) – L bestModel – Adaptive PSO (APSO) Evolutionary PSO (EPSO) – Applications. Problem formulation of VVC, VVC using PSO

UNIT - III	FUNDAMENTALS OF ANT COLONY SEARCH ALGORITHMS	Lecture Hrs: 10

Ant Colony Search Algorithm – Behavior of Real Ants – Ant Colony Algorithms – The Ant System – The Ant Colony System – The Max-Min Ant System – Major Characteristics of Ant Colony Search Algorithm – Distributed Computation: Avoid Premature Convergence – Positive Feedback: Rapid Discovery of Good Solution – Use of Greedy Search and Constructive Heuristic Information: Find Acceptable Solutions in the Early Stage of the Process.

UNIT – IV	FUNDAMENTALS OF TABU SEARCH	Lecture Hrs: 10

Overview of the Tabu Search Approach – Problem Formulation – Coding and Representation – Neighborhood Structure – Characterization of the Neighborhood – Functions and Strategies in Tabu Search – Recency- Based Tabu Search – Basic Tabu Search Algorithm – Candidate List Strategies – Tabu tenure – Aspiration Criteria – The Use of Long Term Memory in Tabu Search – Frequency-Based Memory – Intensification – Diversification – Other TS Strategies – Path Relinking – Strategic Oscillation – Applications of Tabu Search.

UNIT – V	APPLICATION TO POWER SYSTEMS	Lecture Hrs: 9

Introduction to power system applications – Model identifications – Dynamic load modeling – Short term load forecasting – Distribution system applications – Network reconfiguration for loss reduction – Optimal protection and switching devices placements – Examples.

Textbooks:

1. A Ravindran, K.M. Ragsdell, and G.V. Reklaitis, "Engineering optimization : Methods and applications", Wiley India Edition.
2. Kwang Y. Lee and Mohamed A. EI- Sharkawi "Modern Heuristic Optimization Techniques Theory and Applications to Power Systems", A John Wiley & Sons. INC. Publication, 1st edition, 2020
3. D. P. Kothari and J. S. Dhillon, "Power System Optimization", PHI Learning Private Limited, 2nd Edition, 2011.

Reference Books:

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1. Jizhong Zhu, "Optimization of power system operation", IEEE Press, John *Wiley* & Sons, Inc., *Publication, 2nd edition, 2015.*
2. Joshua adam Taylor, "Convex optimization of power systems'', Cambridge University Press, 1st edition, 2015.

Online Learning Resources:

https://nptel.ac.in/courses/112/106/112106064/

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Course Code	SOLAR & WIND ENERGY CONVERSION SYSTEM (PE-II)	L	T	P	C
25MEP104a		3	0	0	3
	Semester	**I**			

Course Objectives: To make the student

- To introduce photovoltaic systems and principle of wind turbines.
- To deal with various technologies of solar PV cells.
- To understand details about manufacture, sizing and operating techniques in solar energy conversion systems.
- Understand the concepts of fixed speed and variable speed, wind energy conversion systems, knowledge of design considerations and analyze grid integration issues.

Course Outcomes (CO): Student will be able to

- Understand the fundamentals of solar cell, Solar PV Modules from solar cells, system types, Standalone PV system configuration, Maximum Power Point tracking (MPPT) and fundamentals the concepts of fixed speed and variable speed, wind energy conversion systems. L2
- Apply the concept of various technologies of solar PV cells, manufacture, sizing and operating techniques. L3
- Analyze the concept of Effect of series and shunt resistance on efficiency, Effect of solar radiation on efficiency, Analytical techniques, Hot spots in the module, Algorithms for MPPT. L4
- Design of PV powered DC fan without battery, Standalone system with DC load using MPPT, PV powered DC pump, standalone system with battery and AC/DC load and control principles of Wind turbine. L5

UNIT – I	**SOLAR & WIND FUNDAMENTALS**	Lecture Hrs: 10

Need for sustainable energy sources – solar radiation – the sun and earth movement – angle of sunrays on solar collectors – sun tracking – estimating solar radiation – measurement of solar radiation. Types of wind energy conversion devices – definition - solidity, tip speed ratio, power coefficient, wind turbine ratings and specifications - aerodynamics of wind rotors - design of the wind turbine rotor – Issues due to integration of solar and wind energy systems.

UNIT – II	**SOLAR PHOTOVOLTAIC MODULES**	Lecture Hrs: 9

Solar PV Modules from solar cells – model of a solar cell, effect of series and shunt resistanceon efficiency, effect of solar radiation on efficiency - series and parallel connection of cells – mismatch in module – mismatch in series connection – hot spots in the module, bypass diode – mismatching in parallel diode – design and structure of PV modules – number of solar cells in a module, wattage of modules, fabrication of PV module – PV module power output.

UNIT - III	**PV SYSTEM DESIGN AND APPLICATIONS**	Lecture Hrs: 09

Introduction to solar PV systems – standalone PV system configuration – design methodology ofPV systems – design of PV powered DC fan without battery, standalone system with DC load using MPPT, design of PV powered DC pump, design of standalone system with battery and AC/DC load – wire sizing in PV system – precise sizing of PV systems – Hybrid PV systems – grid connected PV systems.

UNIT – IV	**WIND TURBINE CONTROL SYSTEMS & SITE ANALYSIS**	Lecture Hrs: 10

Wind Turbine - Torque speed characteristics – Modelling of wind turbines, Pitch angle control – stall control – power electronic control – Yaw control – Control strategy – Wind speed measurements – Wind speed statistics – Site and turbine selection. Constant voltage & constant frequency- single output system –double output system with current converter & voltage source inverter – equivalent circuits – reactive power and harmonics - reactive power compensation – variable voltage, variable frequency – the self-excitation process – circuit model for the self-excited induction generator – analysis of steady state operation – the excitation requirement – effect of a wind generator on the network.

UNIT – V	**WIND GENERATION WITH VARIABLE SPEED TURBINES AND APPLICATIONS**	Lecture Hrs: 10

Classification of schemes – operating area – induction generators – doubly fed induction generator – wound field synchronous generator – the permanent magnet generator – Merits and limitations of wind energy

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conversion systems – application in hybrid energy systems – diesel generator and photovoltaic systems – wind and photovoltaic systems.

Textbooks:

1. "Solar Photovoltaics Fundamentals, Technologies and Applications" by Chetan Singh Solanki, PHI publications, 3rd edition, 2015
2. S.N.Bhadra, D.Kastha, S.Banerjee, " wind electrical systems" Oxford University Press, 1st edition, 2013
3. Banshi D. Shukla, "Engineering of Wind Energy", Jain Brothers, 1st edition, 2018

Reference Books:

1. H.P. Garg, J. Prakash, Solar Energy Fundamentals and applications Tata McGraw- Hill publishers 1st edition, 2000
2. S.Rao & B.B.Parulekar, Energy Technology, Khanna publishers, 4th edition, 2005.
3. N.K.Bansal, M. Kleemann,Michael Meliss, Renewable Energy sources & Conversion Technology, Tata Mcgraw Hill Publishers & Co., 1st edition, 1990

Online Learning Resources:

1. https://www.youtube.com/watch?v=yKgKW4K9ILU
2. http://www.digimat.in/nptel/courses/video/103103206/L37.html

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Course Code	**SMART GRID TECHNOLOGIES**	**L**	**T**	**P**	**C**
25MEP104b	**(PE-II)**	**3**	**0**	**0**	**3**
	Semester	**I**			

Course Objectives: To make the student

- To know the importance of smart grid technology functions over the present grid.
- To get the knowledge about the measurement system and communication technology of Smart grid.
- To enhance the quality, efficiency and security of power supply.
- To impart an understanding of economics, policies and technical regulations for DG integration.

Course Outcomes (CO): Student will be able to

- Understand the importance of smart grid technology functions over the present grid. L2
- Apply the knowledge about the measurement system and communication technology of Smart grid. L3
- Determine the quality, efficiency and security of power supply. L3
- Impart an understanding of economics, policies and technical regulations for DG integration. L2

UNIT – I	**SMART GRIDS**	Lecture Hrs: 08

Smart grid overview- ageing assets and lack of circuit capacity- thermal constraints, operational constraints, security of supply- national initiatives- early smart grid initiatives- active distribution networks- virtual power plant- other initiatives and demonstrations- overview of the technologies required for the smart grid.

UNIT – II	**TRANSMISSION AND DISTRIBUTION MANAGEMENT**	Lecture Hrs: 10

Data Sources- Energy Management System-Wide Area Applications, Visualization Techniques- Data Sources and Associated External Systems- SCADA- Customer Information System- Modeling and Analysis Tools, Distribution System Modeling- Topology Analysis- Load Forecasting- Power Flow Analysis- Fault Calculations- State Estimation- Applications-System Monitoring- Operation- Management- Outage Management System- Overview of energy storage technologies.

UNIT - III	**SMART METERING AND DEMAND SIDE INTEGRATION**	Lecture Hrs: 10

Overview- Smart metering – Evolution of electricity metering- key components of smart metering- smart meters: an overview of the hardware used – signal acquisition- signal conditioning-analogue to digital conversion-computation-input/output and communication. Communication infrastructure and protocols for smart metering - Home area network, Neighborhood Area Network- Data Concentrator- meter data management system- Protocols for communication. Demand Side Integration- Services Provided by DSI-Implementation of DSI- Hardware Support- Flexibility Delivered by consumers from the Demand Side- System Support from DSI.

UNIT – IV	**COMMUNICATION TECHNOLOGIES FOR THE SMART GRID**	Lecture Hrs: 10

Data Communications: Dedicated and Shared Communication Channels, Switching Techniques, Circuit Switching, Message Switching, Packet Switching- Communication Channels, Introduction to TCP/IP.
Communication Technologies: IEEE 802 Series- Mobile Communications- Multi-Protocol Label Switching- Power line Communication.

UNIT – V	**INFORMATION SECURITY FOR THE SMART GRID**	Lecture Hrs: 10

Overview- Encryption and Decryption, Symmetric Key Encryption- Public Key Encryption- Authentication- Authentication Based on Shared Secret Key- Authentication Based on Key Distribution Center- Digital Signatures- Secret Key Signature-Public Key Signature- Message Digest, Introduction to cryptography.

Textbooks:

1. Janaka Ekanayake, Kithsiri Liyanage, et.al., Smart Grid Technology and Applications, Wiley Publications, 1st edition, 2012.
2. James Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley, IEEE Press, 1st edition, 2012.
3. Bharat Modi, Anuprakash, Yogesh Kumar, Fundamentals of Smart Grid Technology, S.K Kataria& Sons, 1st edition, 2019.

Reference Books:

M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

1. Eric D. Knapp, Raj Samani, Applied Cyber Security and the Smart Grid-Implementing Security Controls into the Modern Power Infrastructure, Syngress Publishers, 1st edition, 2013.
2. Nouredine Hadjsaid, Jean Claude Sabonnadiere, Smart Grids, Wiley Blackwell Publications, 1st edition, 2012.
3. Peter-Fox Penner, Smart Power: Climate Changes, the Smart Grid and the future of electric utilities, Island Press, 1st edition, 2010.

Online Learning Resources:

www.indiasmartgrid.org

M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**E-MOBILITY**	**L**	**T**	**P**	**C**
25MEP104c	**(PE-II)**	**3**	**0**	**0**	**3**
	Semester	**I**			

Course Objectives: To make the student

- Remember and Understand the differences between conventional Vehicle and Electric Vehicles, electro mobility and environmental issues of EVs.
- Analyze various EV configurations, parameters of EV systems and Electric vehicle dynamics.
- Analyze the basic construction, operation and characteristics of fuel cells and battery charging techniques in HEV systems.
- Design and analyze the various control structures for Electric vehicle

Course Outcomes (CO): Student will be able to

- To understand and differentiate between Conventional Vehicle and Electric Vehicles, electro mobility and environmental issues of EVs. L2
- To remember and understand various configurations in parameters of EV system and dynamic aspects of EV. L1
- To analyze fuel cell technologies in EV and HEV systems. L4
- To analyze the battery charging and controls required of EVs. L4

UNIT – I	**INTRODUCTION TO EV SYSTEMS AND ENERGY SOURCES**	Lecture Hrs: 10

Past, Present and Future of EV - EV Concept- EV Technology- State-of-the Art of EVs- EV configuration- EV system- Fixed and Variable gearing- Single and multiple motor drive- In-wheel drives- EV parameters: Weight, size, force and energy, performance parameters.
Electro mobility and the environment- History of Electric power trains- Carbon emissions from fuels- Green houses and pollutants- Comparison of conventional, battery, hybrid and fuel cell electric systems.

UNIT – II	**EV PROPULSION AND DYNAMICS**	Lecture Hrs: 08

Choice of electric propulsion system- Block diagram- Concept of EV Motors- Single and multi-motor configurations- Fixed and variable geared transmission- In-wheel motor configuration- Classification- Electric motors used in current vehicle applications- Recent EV Motors- Linear Induction Motors Vehicle load factors- Vehicle acceleration.

UNIT - III	**FUEL CELLS**	Lecture Hrs: 10

Introduction of fuel cells- Basic operation- Model - Voltage, power and efficiency- Power plant system – Characteristics- Sizing - Example of fuel cell electric vehicle.
Introduction to HEV- Brake specific fuel consumption - Comparison of Series-Parallel hybrid systems- Examples.

UNIT – IV	**BATTERY CHARGING AND CONTROL**	Lecture Hrs: 10

Battery charging: Basic requirements- Charger architecture- Charger functions- Wireless charging- Power factor correction.
Control: Introduction- Modeling of electro mechanical system- Feedback controller design approach- PI controllers designing- Torque-loop, Speed control loop compensation- Acceleration of battery electric vehicle.

UNIT – V	**ENERGY STORAGE TECHNOLOGIES**	Lecture Hrs: 10

Role of Energy Storage Systems- Thermal- Mechanical-Chemical- Electrochemical- Electrical - Efficiency of energy storage systems- Super capacitors-Superconducting Magnetic Energy Storage (SMES)- SoC- SoH -fuel cells - G2V- V2G- Energy storage in Micro-grid and Smart grid- Energy Management with storage systems- Hybrid energy storage systems -Battery SCADA.

Textbooks:

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COURSE STRUCTURE & SYLLABI

1. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001,1st Edition
2. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt," Energy Storage in Power Systems" Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016,1st Edition

Reference Books:

1. Electric and Hybrid Vehicles Design Fundamentals, Iqbal Husain, CRC Press 2021,3rd Edition.
2. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2015,1st Edition
3. A.G.Ter-Gazarian, "Energy Storage for Power Systems", the Institution of Engineering and Technology (IET) Publication, UK, (ISBN – 978-1-84919-219-4), Second Edition, 2011.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, "Modern Elelctric, Hybrid Elelctric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2004,1st Edition
4. James Larminie, John Lowry, "Electric Vehicle Technology Explained", Wiley, 2003,2nd Edition.

Online Learning Resources:

1. https://nptel.ac.in/courses/108/102/108102121/
2. https://nptel.ac.in/syllabus/108103009

M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**POWER SYSTEM ANALYSIS AND PROTECTION LAB**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
	Semester	**I**			

Course Objectives: To make the student

- Understand the experiments ensuring the safety of equipment and personnel.
- Analyze the power system data fault studies.
- Interpret the experimental results and correlating them with the practical power system.
- Design the relays for power system protection purpose.

Course Outcomes (CO): Student will be able to

- Understand the concept of different experiments. L2
- Analyze the data for and compute the data to obtain results. L4
- Apply the computational results to solve the original power system problems. L4
- Develop advanced relays to identify various faults. L5

List of Experiments:

1. Determination of Subtransient Reactance and Time Constant of a Salient Pole Machine
2. Determination of Sequence Impedances of a Cylindrical Rotor Synchronous Machine
3. Fault Analysis
   - i) LG Fault
   - ii) LL Fault
   - iii) LLG Fault
   - iv) LLLG Fault
4. Equivalent Circuit of a Three Winding Transformer
5. Separation of No Load losses of a Three Phase Squirrel Cage Induction Motor
6. Power Angle Characteristics of a Salient Pole Synchronous Machine
7. Characteristics of Static/Numeric Over Current Relay
8. Characteristics of Static Negative Sequence Relay
9. Characteristics of Static/Numeric Over Voltage Relay
10. Characteristics of Static/Numeric Percentage Biased Differential Relay
11. Testing of Buchholz Relay
12. Testing of Frequency Relay
13. Testing of Reverse Power Relay
14. Testing of Earth fault Relay
15. Microprocessor Based Relay

Web Sources: https://www.vlab.co.in

M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	POWER SYSTEMS SIMULATION LAB	L	T	P	C
		0	0	4	2
	Semester	I			

Course Objectives: To make the student

- Understand how to write the coding in simulation.
- Analyze the data related to load flows, economic dispatch problem and transient stability analysis.
- Apply the computational results in real life power system problems.
- Have the capabilities to develop new software's to optimize the results.

Course Outcomes (CO): Student will be able to

- Understand the coding in simulation. L2
- Analyze the power system data for load-flow and stability studies. L4
- Apply computational methods for large scale power system studies. L3
- Develop software for power system industry to solve various issues. L5

List of Experiments:

1. Y - Bus Formation
2. Z- Bus Formation
3. Gauss – Seidel Load Flow Analysis
4. Newton-Raphson Method for Load Flow Analysis
5. Fast Decoupled Load Flow Analysis
6. Fast Decoupled Load Flow Analysis for Distribution Systems
7. Point by Point Method
8. Computation of Available Transfer Capabilities
9. Contingency analysis
10. State estimation using Weighted Least Square, linear and non-linear methods
11. Simulation of power quality problems (Sag/Swell, interruption, transients, harmonics, flickers etc.)
12. Harmonic analysis and Single tuned filter design to mitigate harmonics
13. Harmonic analysis and Double tuned filter design to mitigate harmonics

Web Sources: https://www.vlab.co.in

M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	AI TECHNIQUES IN ELECTRICAL ENGINEERING (SE)	L	T	P	C
		2	0	0	2
	Semester	**I**			

Course Objectives: To make the student

- To locate soft commanding methodologies, such as artificial neural networks, Fuzzy logic and genetic Algorithms.
- To observe the concepts of feed forward neural networks and about feedback neural networks.
- To practice the concept of fuzziness involved in various systems and comprehensive knowledge of fuzzy logic control and to design the fuzzy control.
- To analyze genetic algorithm, genetic operations and genetic mutations.

Course Outcomes (CO): Student will be able to

- Understand feed forward neural networks, feedback neural networks and learning techniques. L2
- Apply selected basic AI techniques; judge applicability of more advanced techniques. L3
- Analyze &Develop fuzzy logic control for applications in electrical engineering. L4
- Develop genetic algorithm for applications in electrical engineering. L5

UNIT - I	**ARTIFICIAL NEURAL NETWORKS**	Lec Hrs: 10

Introduction-Models of Neural Network - Architectures – Knowledge representation – Artificial Intelligence and Neural networks – Learning process – Error correction learning – Hebbian learning – Competitive learning – Boltzmann learning – Supervised learning –Unsupervised learning – Reinforcement learning -learning tasks.

UNIT - II	**ANN PARADIGMS**	Lec Hrs: 9

Multi – layer perceptron using Back propagation Algorithm-Self – organizing Map –Radial Basis Function Network– Functional link network– Hopfield Network.

UNIT - III	**FUZZYLOGIC**	Lec Hrs: 9

Introduction – Fuzzy versus crisp – Fuzzy sets - Membership function – Basic Fuzzy set operations –Properties of Fuzzy sets – Fuzzy Cartesian Product – Operations on Fuzzy relations – Fuzzy logic – Fuzzy Quantifiers-Fuzzy Inference- Fuzzy Rule based system– Defuzzification methods.

UNIT - IV	**GENETIC ALGORITHMS**	Lec Hrs: 10

Introduction-Encoding– Fitness Function-Reproduction operators–Genetic Modeling –Genetic operators- Crossover-Single–site crossover –Two-point crossover–Multi point crossover-Uniform crossover–Matrix crossover-Crossover Rate-Inversion & Deletion–Mutation operator–Mutation–Mutation Rate-Bit-wise operators-Generational cycle-convergence of Genetic Algorithm. Over view of Heuristics, Bio-inspired algorithms, Optimization algorithms.

UNIT - V	**APPLICATIONS OF AI TECHNIQUES**	Lec Hrs: 10

Load forecasting – Load flow studies – Economic load dispatch –Load frequency control – Single area system and two area system – Small Signal Stability (Dynamic stability)- Reactive power control – speed control of DC and AC Motors. Over view of different types of algorithms

Textbooks:

1.S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms" PHI,New Delhi, 2nd edition,2017.

2.Sudarshan K. Valluru and T. Nageswara Rao, "introduction to Neural Networks, Fuzzy Logic & Genetic Algorithms", Jaico Publishing House, 1st edition, 2010.

Reference Books:

1. P.D.Wasserman, VanNostrand Reinhold," NeuralComputingTheory&Practice",NewYork,1st . Eddition ,1989
2. Bart Kosko,"Neural Network & Fuzzy System", Prentice Hall,1992.
3. G.J.Klir and T.A.Folger, "Fuzzy sets, Uncertainty and Information", Pearson, 1st edition, 2015.
4. D.E.Goldberg, "Genetic Algorithms", Pearson Education India, 1st edition, 2008.

Online Learning Resources:

1. **https://onlinecourses.swayam2.ac.in/ntr24_ed08/preview**
2. **https://onlinecourses.nptel.ac.in/noc23_ge36/preview**
3. **https://onlinecourses.nptel.ac.in/noc22_hs59/preview**

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COURSE STRUCTURE & SYLLABI

Course Code	RESEARCH METHODOLOGY AND IPR	L	T	P	C
25MRM101		2	0	0	2
	Semester	**I**			

Course Objectives:

- Identify an appropriate research problem in their interesting domain.
- Understand ethical issues understand the Preparation of a research project thesis report.
- Understand the Preparation of a research project thesis report
- Understand the law of patent and copyrights.
- Understand the Adequate knowledge on IPR

Course Outcomes (CO): Student will be able to

- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT - I	Lecture Hrs: 9

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, scope, and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary Instrumentations

UNIT - II	Lecture Hrs:10

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, howto write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT - III	Lecture Hrs: 10

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperationon Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT - IV	Lecture Hrs: 9

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT - V	Lecture Hrs: 10

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Textbooks:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

Reference Books:

1. 1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for
2. beginners"
3. 2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
4. 3. Mayall, "Industrial Design", McGraw Hill, 1992.
5. 4. Niebel, "Product Design", McGraw Hill, 1974.
6. 5. Asimov, "Introduction to Design", Prentice Hall, 1962.
7. 6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New
8. Technological Age", 2016.