ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES
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UTUKUR (P), C.K.DINNE(M&V), KADAPA ,YSR DIST
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Accredited by NAAC with 'A' Grade

M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

SEMESTER – I

Sl. No.	Course Code	Course Name	Category	Hours Per Week			Credits
				L	T	P	
1	21D07101	Advanced Power System Protection	PC	3	0	0	3
2	21D07102	Power System Security and State Estimation	PC	3	0	0	3
3	21D07103a 21D07103b 21D07103c	**Program Elective I:** Energy Auditing and Management Modelling and Analysis of HVDC Systems Power System Optimization	PE	3	0	0	3
4	21D07104a 21D07104b 21D07104c	**Program Elective II:** Solar & Wind Energy Conversion Systems Smart Grid Technologies Electric Vehicle Engineering	PE	3	0	0	3
5	21D07105	Machines & Power Systems Lab	PC	0	0	4	2
6	21D07106	Power Systems Simulation Lab	PC	0	0	4	2
7	21DRM101	Research Methodology and IPR	MC	2	0	0	2
8	21DAC101a 21DAC101b 21DAC101c	**Audit Course – I:** English for Research paper writing Disaster Management Sanskrit for Technical Knowledge	AC	2	0	0	0
		Total					**18**

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

SEMESTER – II

Sl. No.	Course Code	Course Name	Category	Hours Per Week			Credits
				L	T	P	
1	21D07201	Power System Stability and Control	PC	3	0	0	3
2	21D07202	FACTS Controllers	PC	3	0	0	3
3	21D07203a 21D07203b 21D07203c	**Program Elective III:** Power System Wide Area Monitoring & Control Modern Control Theory Reactive power Compensation & Management	PE	3	0	0	3
4	21D07204a 21D07204b 21D07204c	**Program Elective IV:** Power Quality Distributed Generation and Micro grid Control EHVAC Transmission systems	PE	3	0	0	3
5	21D07205	Renewable Energy Sources Lab	PC	0	0	4	2
6	21D07206	FACTS Devices Simulation Lab	PC	0	0	4	2
7	21D07207	Technical seminar	PR	0	0	4	2
8	21DAC201a 21DAC201b 21DAC201c	**Audit Course – II:** Pedagogy Studies Stress Management for Yoga Personality Development through Life Enlightenment Skills	AC	2	0	0	0
		Total					**18**

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Course Code	ADVANCED POWER SYSTEM PROTECTION	L	T	P	C
21D07101		3	0	0	3
	Semester	I			

Course Objectives: To make the student

- To know construction of static relays
- 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.
- To know the operation of microprocessor based protective relays

Course Outcomes (CO): Student will be able to

- Describe the construction of static relay and identify the advantages of static relay over electromagnetic relay Analyse the importance of reliability in various fields.
- Explore the operation of rectifier bridge comparators, instantaneous comparators, phase comparators, multi input comparators, static differential and distance relays
- Describe instantaneous, definite time and inverse definite minimum time over current relays.
- Analyze the concept of power swings on distance relays and to identify the microprocessor based protective relays and their operation

UNIT – I	STATIC RELAYS & COMPARATORS	Lecture Hrs: 8

Static relays - Basic construction of Static relays – Level detectors – Replica Impedance-Mixing circuits-General equation for two input phase and Amplitude Comparators – their types – Duality between Amplitude and Phase Comparator –Conic section characteristics–Three input Amplitude Comparator – Hybrid comparator – Switched distance schemes – Polyphase distance schemes-Phase faults scheme –Three phase scheme–Combined and Ground fault scheme.

UNIT - II	TYPES OF STATIC RELAYS	Lecture Hrs: 9

Instantaneous over current relay – Time over current relays - Basic principles - Definite time and Inverse definitetime 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	NUMERICAL RELAYS:	Lecture Hrs: 9

Advantages of Numerical Relays – Numerical network-Digital Signal processing–Estimation of Phasors – Full Cycle Fourier Algorithm – Half Cycle Fourier Algorithm- practical considerations for selection of Algorithm– Discrete Fourier Transform

UNIT - IV	DISTANCE RELAYS AND POWER SWINGS	Lecture Hrs: 12

Static Distance Relays - Static Impedance - reactance - MHO and Angle Impedance relay sampling comparator – Realization of reactance and MHO relay using a sampling comparator.
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 - V	MICROPROCESSOR BASED PROTECTIVE RELAYS	Lecture Hrs: 10

Over current relays – Impedance relays – Directional relay – Reactance relay (Block diagram and flowchart approach only).Generalized mathematical expression for distance relays-Measurement of resistance and reactance – MHO and offset MHO relays – Realization of MHO characteristics – Realization of Offset MHO characteristics (Block diagram and flow chart approach only) - Basic principle of Digital computer relaying.

Text Books:
1. T.S. Madhava Rao, Power system Protection static relay, Tata McGrawHill Publishing Company limited, 2nd Edition, 2004. 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.

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**POWER SYSTEM SECURITY AND STATE ESTIMATION**	**L**	**T**	**P**	**C**
21D07102		**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.
- Analyze the bus admittance/impedance matrices methods, power system security, sensitivity factors, state estimation and electricity structure model.
- Apply the methods for evaluating the bus matrices, sparsity, DC power flow, AC power flow, estimating a value and Available Transfer Capability (ATC).
- Develop the methods for state estimation, method to identify network problems and methods for congestion management.

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-simple problems – 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– Simple problems.

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:
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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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**ENERGYAUDITING AND MANAGEMENT**	**L**	**T**	**P**	**C**
21D07103a	**(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
- Acquire the knowledge about different energy efficient devices
- Measure efficiency in renewable energy resources.
- Identify the equipment and areas of a system where energy conservation and Audit is necessary

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
.

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,2008.
2. WC Turner: Energy Management Handbook, Seventh Edition, (Fairmont Press Inc., 2007)
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.
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.

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**MODELLING AND ANALYSIS OF HVDC TRANSMISSION SYSTEMS (PE-I)**	**L**	**T**	**P**	**C**
21D07103b		**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.
- Analyze the different modes of operation for six pulse & twelve pulse converter unit in the context of HVDC system.
- Apply the knowledge of HVDC transmission in Power networks.
- Determine the appropriate HVDC transmission line parameters under different physical conditions

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.

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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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**POWER SYSTEM OPTIMIZATION**	**L**	**T**	**P**	**C**
21D07103c	**(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.
- Analyze the concept of different optimization techniques in real world applications.
- Solve various constrained and unconstrained problems in single variable as well as multivariable.
- Design the methods of optimization for real life situation.

UNIT – I	**CONVENTIONAL OPTOMIZATION TECHNIQUES & FUNDAMENTALS OF PARTICLE SWARM OPTIMIZATION (PSO) 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.

Background of PSO – Original PSO – Variation of PSO – Discrete PSO – PSO for MINLPs – Constriction Factor Approach (CFA) – Hybrid PSO (HPSO) – L best Model – Adaptive PSO (APSO) Evolutionary PSO (EPSO) – Applications.

UNIT – II	**FUNDAMENTALS OF ANT COLONY SEARCH ALGORITHMS**	Lecture Hrs: 9

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 - III	**FUNDAMENTALS OF TABU SEARCH**	Lecture Hrs: 12

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 – IV	**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.

UNIT – V	**POWER SYSTEM CONTROLS**	Lecture Hrs: 9
Overview – Power system controls: Particle Swarm Technique – Problem formulation of VVC – State variables – Problem formulation – Expansion of PSO for MINLP – Voltage security assessment – VVC using PSO – Treatment of state variables – VVC algorithm using PSO – Numerical Examples – IEEE 14 Bus system.		
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:		
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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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	SOLAR & WIND ENERGY CONVERSION SYSTEM (PE-II)	L	T	P	C
21D07104a		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.
- To have 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.
- Apply the concept of various technologies of solar PV cells, manufacture, sizing and operating techniques.
- 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 and
- 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.

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 resistance on 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: 10

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 - 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: 11
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 conversion systems – application in hybrid energy systems – diesel generator and photovoltaic systems – wind 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

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**SMART GRID TECHNOLOGIES**	**L**	**T**	**P**	**C**
21D07104b	**(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.
- Apply the knowledge about the measurement system and communication technology of Smart grid.
- Determine the quality, efficiency and security of power supply.
- Impart an understanding of economics, policies and technical regulations for DG integration.

UNIT – I	**SMART GRIDS**	Lecture Hrs: 10

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: 11

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.

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:

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

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES
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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	ELECTRIC VEHICLE ENGINEERING	L	T	P	C
21D07104c	(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.
- To remember and understand various configurations in parameters of EV system and dynamic aspects of EV.
- To analyze fuel cell technologies in EV and HEV systems.
- To analyze the battery charging and controls required of EVs.

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: 10

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- 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: 12

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:

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:

4. Electric and Hybrid Vehicles Design Fundamentals, Iqbal Husain, CRC Press 2021,3rd Edition.
5. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2015,1st Edition
6. 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.
5. 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
6. 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

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**MACHINES & POWER SYSTEMS LAB**	**L**	**T**	**P**	**C**
21D07105		**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.
- Analyze the data for and compute the data to obtain results.
- Apply the computational results to solve the original power system problems.
- Develop advanced relays to identify various faults.

List of Experiments:

1. Determination of Subtransient Reactance 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

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

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**POWER SYSTEMS SIMULATION LAB**	**L**	**T**	**P**	**C**
21D07106		**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
- Analyze the power system data for load-flow and stability studies.
- Apply computational methods for large scale power system studies.
- Develop software for power system industry to solve various issues.

List of Experiments:

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

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

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	RESEARCH METHODOLOGY AND IPR	L	T	P	C
21DRM101		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:

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:

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

UNIT - III		Lecture Hrs:

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

UNIT - IV		Lecture Hrs:

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

UNIT - V		

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

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
21DAC101a		2	0	0	0
	Semester	I			

Course Objectives: This course will enable students:

- Understand the essentials of writing skills and their level of readability
- Learn about what to write in each section
- Ensure qualitative presentation with linguistic accuracy

Course Outcomes (CO): Student will be able to

- Understand the significance of writing skills and the level of readability
- Analyze and write title, abstract, different sections in research paper
- Develop the skills needed while writing a research paper

UNIT - I	Lecture Hrs:10

1Overview of a Research Paper- Planning and Preparation- Word Order- Useful Phrases - Breaking up Long Sentences-Structuring Paragraphs and Sentences-Being Concise and Removing Redundancy -Avoiding Ambiguity

UNIT - II	Lecture Hrs:10

Essential Components of a Research Paper- Abstracts- Building Hypothesis-Research Problem - Highlight Findings- Hedging and Criticizing, Paraphrasing and Plagiarism, Cauterization

UNIT - III	Lecture Hrs:10

Introducing Review of the Literature – Methodology - Analysis of the Data-Findings - Discussion-Conclusions-Recommendations.

UNIT - IV	Lecture Hrs:9

Key skills needed for writing a Title, Abstract, and Introduction

UNIT - V	Lecture Hrs:9

Appropriate language to formulate Methodology, incorporate Results, put forth Arguments and draw Conclusions

Suggested Reading

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books) Model Curriculum of Engineering & Technology PG Courses [Volume-I]
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	DISASTER MANAGEMENT	L	T	P	C
21DAC101b		2	0	0	0
	Semester	I			

Course Objectives: This course will enable students:

- Learn to demonstrate critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from Multiple perspectives.
- Developanunderstandingofstandardsofhumanitarianresponseandpracticalrelevanceinspecific types of disasters and conflict situations
- Criticallyunderstandthestrengthsandweaknessesofdisastermanagementapproaches,planningand programming in different countries, particularly their home country or the countries they work in

UNIT - I

Introduction:

Disaster:Definition,FactorsandSignificance;DifferenceBetweenHazardandDisaster;Naturaland Manmade Disasters: Difference, Nature, Types and Magnitude.

Disaster Prone Areas in India:

Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post- Disaster Diseases and Epidemics

UNIT - II

Repercussions of Disasters and Hazards:

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes,Volcanisms,Cyclones,Tsunamis,Floods,DroughtsandFamines,Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT - III

Disaster Preparedness and Management:

Preparedness: Monitoring of Phenomena Triggering ADisasteror Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT - IV

Risk Assessment Disaster Risk:

Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. TechniquesofRiskAssessment,GlobalCo-OperationinRiskAssessmentand Warning, People's Participation in Risk Assessment. Strategies for Survival.

UNIT - V		
Disaster Mitigation: Meaning,ConceptandStrategiesofDisasterMitigation,EmergingTrendsInMitigation.Structural Mitigationand Non-Structural Mitigation, Programs of Disaster Mitigation in India.		
Suggested Reading		
1. R.Nishith,SinghAK,"DisasterManagementinIndia:Perspectives,issuesandstrategies" New Royal book Company.. 2. Sahni,PardeepEt.Al.(Eds.),"DisasterMitigationExperiencesAndReflections",PrenticeHa ll OfIndia, New Delhi. 3. GoelS.L.,DisasterAdministrationAndManagementTextAndCaseStudies ",Deep&Deep Publication Pvt. Ltd., New Delhi		

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	SANSKRITFOR TECHNICAL KNOWLEDGE	L	T	P	C
21DAC101c		2	0	0	0
	Semester	I			

Course Objectives: This course will enable students:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- LearningofSanskrittodevelopthelogicinmathematics,science&othersubjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge
- Knowledge from ancientliterature

Course Outcomes (CO): Student will be able to

- Understanding basic Sanskrit language
- Ancient Sanskrit literature about science &technology can be understood
- Being a logical language will help to develop logic in students

UNIT - I		
Alphabets in Sanskrit,		
UNIT - II		
Past/Present/Future Tense, Simple Sentences		
UNIT - III		
Order, Introduction of roots		
UNIT - IV		
Technical information about Sanskrit Literature		
UNIT - V		
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics		

Suggested Reading

1.“Abhyaspustakam” –Dr.Vishwas, Sanskrit-Bharti Publication, New Delhi
2.“Teach Yourself Sanskrit” Prathama Deeksha- VempatiKutumbshastri, RashtriyaSanskrit Sansthanam, New Delhi Publication
3.“India’s Glorious ScientificTradition” Suresh Soni, Ocean books (P) Ltd.,New Delhi

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**POWER SYSTEM STABILITY & CONTROL**	**L**	**T**	**P**	**C**
21D07201		**3**	**0**	**0**	**3**
	Semester	**II**			

Course Objectives: To make the student

- Understand about linear and nonlinear models of multi-machine power systems.
- Analyze various types of stability properties of power systems.
- Identify power system models from dynamic data and simulate excitation mechanisms in synchronous machines.
- Design excitation systems and their state space model equations for further stability applications.

Course Outcomes (CO): Student will be able to

- Understand the concepts of single and multi-machine systems connected to infinite bus bar.
- Analyze system responses to small disturbances and concept of dynamic stability and power system stabilizers.
- Apply the various stability methods to evaluate the stability of the system.
- Design the state space model equations for excitation systems and methods for finding voltage and angle instability.

UNIT - I	**THE ELEMENTARY MATHEMATICAL MODEL**	Lecture Hrs: 10

Introduction to equal area criteria – Power Angle curve of a Synchronous Machine – Model of single machine connected to an infinite bus – Model of multimachine system – Problems – Classical Stability Study of multimachine system – Effect of the excitation system on Transient stability.

UNIT - II	**SYSTEM RESPONSE TO SMALL DISTURBANCES AND DYNAMIC STABILITY**	Lecture Hrs: 8

The unregulated synchronous Machine – Modes of oscillation of an unregulated multimachine system – Regulated synchronous machine – Voltage regulator with one time lag – Governor withone time lag – Problems - Concept of Dynamic stability – State-space model of single machine system connected to infinite bus – Effect of excitation on Dynamic stability – Examination of dynamic stability by Routh-Hurwitz criterions.

UNIT - III	**POWER SYSTEM STABILIZERS**	Lecture Hrs: 12

Introduction to supplementary stabilizing signals – Block diagram of the linear system – Approximate model of the complete exciter – Generator system – Lead compensation – Stability analysis using eigen value approach.

UNIT - IV	**EXCITATION SYSTEMS**	Lecture Hrs:12

Introduction to excitation systems – Non-continuously, Continuously regulated systems – Excitation system compensation – State-space description of the excitation system – Simplified linear model – Effect of excitation on generator power limits. Type- 2, Type-3 and Type-4 excitation systems and their state-space modeling equations.

UNIT - V	**STABILITY ANALYSIS**	Lecture Hrs:10

Review of Lyapunov's stability of non-liner systems using energy concept – Method based on first concept – Method based on first integrals – Zubov's method – Popov's method – Lyapunov function for single machine connected to infinite bus – Voltage stability – Factors affecting voltage instability and collapse – Comparison of Angle and Voltage stability – Analysis of voltage instability and collapse – Control of voltage instability.

Textbooks:
1. Vijay Vittal, James D. McCalley, Paul M. Anderson "Power System Control and Stability", Jhon Willey and Sons, 3rd edition, 2019. 2. **Prabha Kundur**, "Power System Control and Stability", McGraw Hill Education India, 1st edition, 5th reprint, 2008.
Reference Books:
1. Dr Jan Machowski, Dr Janusz W. Bialek, Dr Jim Bumby · "Power System Dyanmics: Stability and Control", Jhon willey and Sons, 2nd Edition, 2011. 2. M.A.Pai, Power System Stability-Analysis by the direct method of Lyapunov, North HollandPublishing Company, New York, 1st edition,1981.
Online Learning Resources:
https://nptel.ac.in/courses/108/105/108105133/

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	FACTS CONTROLLERS	L	T	P	C
21D07202		3	0	0	3
	Semester	II			

Course Objectives: To make the student

- To understand the fundamentals of FACTS Controllers, Importance of controllable parameters and types of FACTS controllers & their benefits
- To explain control of STATCOM and SVC and their comparison and the regulation of STATCOM
- To remember the objectives of Shunt and Series compensation
- To analyze the functioning and control of GCSC, TSSC and TCSC

Course Outcomes (CO): Student will be able to

- Understand various control techniques for the purpose of identifying the scope and for selection of specific FACTS controllers.
- Remember different types of controllable VAR generation and variable impedance techniques.
- Design simple converters using FACTS controllers.
- Understand the operation of Unified Power Controller and Hybrid Arrangements.

UNIT - I	FACTS CONCEPTS, VSI AND CSI	Lecture Hrs: 10

Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits fromFACTS controllers. Single phase three phase full wave bridge converters transformer connections for 12 pulse 24 and 48 pulse operation. Three level voltage source converter, pulse width modulation converter, basic concept of current source Converters, and comparison of current source converters with voltage source converters.

UNIT - II	SHUNT COMPENSATION	Lecture Hrs: 8

Objectives of shunt compensation - Methods of controllable var generation - Variable impedance type static var generators - switching converter type var generators - hybrid var generators – Comparison of SVC and STATCOM.

UNIT - III	SERIES COMPENSATION	Lecture Hrs: 12

Objectives of series compensation – GTO Thyristor Controlled Series Capacitor (GCSC) - Thyristor Switched Series Capacitor (TSSC) - Thyristor Controlled Series Capacitor (TCSC) - Control schemes for TCSC, TSSC and TCSC.

UNIT - IV	UNIFIED POWER FLOW CONTROLLER (UPFC)	Lecture Hrs:12

Introduction - The Unified Power Flow Controller - Basic Operating Principles - Conventional Transmission Control Capabilities - Independent Real and Reactive Power Flow Control - Control Structure - Basic Control System for P and Q Control - Hybrid Arrangements: UPFC With a Phase Shifting Transformer.

UNIT - V	INTERLINE POWER FLOW CONTROLLER (IPFC)	Lecture Hrs:10

Introduction, basic operating principle and characteristics of IPFC, control structure, practical and application considerations, generalized and multifunctional fact controllers

Textbooks:

1. Understanding FACTS – Concepts and technology of Flexible AC Transmission systems, Narain G. Hingorani, Laszlo Gyugyi, IEEE Press, WILEY, 1st Edition, 2000, Reprint 2015.
2. FACTS Controllers in Power Transmission and Distribution, Padiyar K.R., New Age International Publishers, 1st Edition, 2007.

Reference Books:

1. Flexible AC Transmission Systems: Modelling and Control, Xiao – Ping Zhang, Christian Rehtanz, Bikash Pal, Springer, 2012, First Indian Reprint, 2015.

2. FACTS – Modelling and Simulation in Power Networks, Enrigue Acha, Claudio R. Fuerte – Esquival, Huge Ambriz – perez, Cesar Angeles – Camacho, WILEY, 1st edition, 2004

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	POWER SYSTEM WIDE AREA MONITORING AND CONTROL (PE – III)	L	T	P	C
21D07203a		3	0	0	3
	Semester	II			

Course Objectives: To make the student

- To know the necessity of real-time computer control of power systems and wide area measurement system.
- To get the knowledge of different automation systems.
- To know the complete fundamentals of SCADA and its importance in real time powersystems.
- To get the knowledge about Substation Automation, New Digital Substation and traditional approach and IED-based approach of Integrated Protective Functions.
- To study about Voltage stability, prevention of voltage collapse and dynamic stabilityanalysis.

Course Outcomes (CO): Student will be able to

- Know the necessity of real-time computer control of power systems and wide area measurement system.
- Get the knowledge of different automation systems.
- Know the complete fundamentals of SCADA and its importance in real time powersystems.
- Get the knowledge about Substation Automation, New Digital Substation and traditional approach and IED-based approach of Integrated Protective Functions.
- Study about Voltage stability, prevention of voltage collapse and dynamic stabilityanalysis.

UNIT - I	COMPUTER CONTROL OF POWER SYSTEMS	Lecture Hrs: 10

Need for computer control of power systems, Operating states of a power system, Supervisory Control and Data Acquisition system, Energy control centers. Wide Area Measurement system (WAMS): Architecture, Components of WAMS, Applications: Voltage Stability Assessment, Frequency stability Assessment, Power Oscillation Assessment, Communication needs of WAMS, Wide Area Monitoring Protection & Control, and Remedial Action Scheme.

UNIT - II	POWER SYSTEM AUTOMATION	Lecture Hrs: 8

Introduction, Evolution of Automation Systems, History of Automation Systems, Supervisory Control and Data Acquisition (SCADA) Systems, Components of SCADA Systems, SCADA Applications, SCADA in Power Systems, SCADA Basic Functions, SCADA Application Functions, Advantages of SCADA in Power Systems, Deferred Capital Expenditure, Optimized Operation and Maintenance Costs, Equipment Condition Monitoring (ECM), Sequence of Events (SOE) Recording, Power Quality Improvement, Data Warehousing for Power Utilities, Power System Field, Transmission and Distribution Systems, Customer Premises, Types of Data and Signals in Power Systems, Flow of Data from the Field to the SCADA Control Center

UNIT - III	SCADA FUNDAMENTALS	Lecture Hrs: 12

Introduction, Open System: Need and Advantages, Building Blocks of SCADA Systems, Remote Terminal Unit (RTU), Evolution of RTUs, Components of RTU, Communication Subsystem, Logic Subsystem Termination Subsystem, Testing and Human-Machine Interface (HMI) Subsystem, Power Supplies, Advanced RTU Functionalities, Intelligent Electronic Devices (IEDs), Evolution of IEDs, IED Functional Block Diagram, Hardware and Software Architecture of the IED, IED Communication Subsystem, IED Advanced Functionalities, Tools for Settings, Commissioning, and Testing, Programmable LCD Display, Typical IEDs, Data Concentrators and Merging Units, RTUs, IEDs, and Data Concentrator, Merging Units andIEDs.

UNIT - IV	**SUBSTATION AUTOMATION**	Lecture Hrs:12
Substation Automation: Technical Issues, System Responsibilities, System Architecture, Substation Host Processor, Substation LAN, User Interface, Communications Interfaces, Protocol Considerations. The New Digital Substation, Process Level, Protection and Control Level, Station Bus and Station Level, Substation Automation Architectures, Legacy Substation Automation System, Digital Substation Automation Design, New versus Existing Substations. Drivers of Transition, Migration Paths and the Steps Involved, Value of Standards in Substation Automation, Substation Automation (SA) Application Functions, Integrated Protection Functions: Traditional Approach and IED-Based Approach. Automation Functions, Enterprise- Level Application Functions.		
UNIT - V	**VOLTAGE STABILITY**	Lecture Hrs:10
Basic concepts, Voltage collapse – general characterization, classification, Voltage stability analysis – modeling, dynamic analysis, static analysis, shortest distance to instability, continuation power flow analysis, prevention of voltage collapse – design measures, operating measures.		
Textbooks:		
1. Allen J. Wood and Bruce Woolenberg, Power System Generation, Operation and Control, John Wiley and Sons, 3rd edition, 2013. 2. **Prabha Kundur**, "Power System Control and Stability", McGraw Hill Education India, 1st edition, 5th reprint, 2008. 3. Mini S. Thomas and John Douglas McDonald, Power System SCADA and Smart Grids,CRC Press, 1st edition, 2015.		
Reference Books:		
1. E. Handschin, Real-time Control of Electrical Power Systems, Elsevier Publications & Co, 1st edition,1988. 2. Special Issue on Computer Control of Power Systems, IEEE Proc, July 1974.		

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	MODERN CONTROL THEORY	L	T	P	C
21D07203b	(PE-III)	3	0	0	3
	Semester	II			

Course Objectives: To make the student

- Remember and understand the concept of state space representation, Solution of state equation, STM, linearization of nonlinear systems, controllability and observability concepts, principles of duality, concepts of optimal and Lyapunov stability.
- Apply the above concepts to analyze controllability, Observability and pole placement by state feedback
- Analyze the concept of regulator, stability and sensitivity using various methods and disturbance rejection
- Design Full order observer and reduced order observer.

Course Outcomes (CO): Student will be able to

- Understand the state space representation, controllability and observability concepts, principles of duality, concepts of optimal and Lyapunov stability.
- Apply the state equations, pole placement by state feedback.
- Analyze controllability & observability of state models.
- Design full order observer and reduced order observer.

UNIT - I	STATE VARIABLE DISCRIPTION	Lecture Hrs: 10

Introductory matrix algebra and linear Vector Space, State space representation of systems- Linearization of a non-linear System- Solution of state equations- Evaluation of State Transition Matrix (STM).

UNIT - II	TRANSFORMATION, POLEPLACEMENT AND CONTROLLABILITY	Lecture Hrs: 8

Similarity transformation and invariance of system properties due to similarity transformations. Minimal realization of SISO, SIMO and MISO transfer functions. Discretization of a continuous time state space model- Conversion of state space model to transfer function model using Fadeeva algorithm- Fundamental theorem of feedback control - Controllability and Controllable canonical form - Pole assignment by state feedback using Ackermann‘s formula– Eigen structure assignment problem.

UNIT - III	OPTIMAL CONTROL	Lecture Hrs: 12

Linear Quadratic Regulator (LQR) problem and solution of algebraic Riccati equation using Eigen value and Eigen vector methods- iterative method- Controller design using output feedback.

UNIT - IV	OBSERVERS	Lecture Hrs:12

Observability and observable canonical form-Design of full order observer using Ackermann‘s formula -Bass Gura algorithm- Duality between controllability and observability- Full order Observer based controller design- Reduced order observer design.

UNIT - V	STABILITY ANALYSIS AND SENSITIVITY	Lecture Hrs:10

Internal stability of a system- Stability in the sense of Lyapunov- Asymptotic stability of linear time invariant continuous and discrete time systems- Solution of Lyapunov type equation- Model decomposition and decoupling by state feedback- Disturbance rejection- sensitivity and complementary sensitivity functions.

Textbooks:

1. K. Ogata, "Modern Control Engineering", Prentice Hall, India, 5th edition, 2010.
2. T. Kailath, "Linear Systems", Prentice Hall, 2016.
3. N.K. Sinha, "Control Systems", New Age International, 4th edition, 2013.

Reference Books:

1. Panos J Antsaklis, and Anthony N.Michel,"LinearSystems", New-age international (P) LTD.Publishers, 2009.
2. John JD Azzoand C. H. Houpis, "Linear Control System Analysis and Design conventional and Modern", Mc Graw- Hill Book Company, 3rd edition, 1988.
3. B.N.Dutta, "Numerical Methods for linear Control Systems", Elsevier Publication, 2007.
4. C.T. Chen "Linear System Theory and Design-PHI, India,1984.
5. Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", 11th Edition, Pearson Edu., India, 2009

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**REACTIVE POWER COMPENSATION & MANAGEMENT (PE– III)**	**L**	**T**	**P**	**C**
21D07203c		**3**	**0**	**0**	**3**
	Semester	**II**			

Course Objectives: To make the student

- To identify the necessity of reactive power compensation
- To describe load compensation and various types of reactive power compensation in transmission systems
- To illustrate reactive power coordination system
- To characterize distribution side and utility side reactive power management.

Course Outcomes (CO): Student will be able to

- Understand the importance of load compensation in symmetrical as well as unsymmetrical loads
- Analyze various compensation methods in transmission lines
- Design model for reactive power coordination
- Distinguish demand side reactive power management & user side reactive power management

UNIT - I	**LOAD COMPENSATION**	Lecture Hrs: 10

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 - Examples.

UNIT - II	**STEADY STATE & TRANSIENT STATE REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEM**	Lecture Hrs: 8

Uncompensated line – Types of compensation – Passive shunt and series and dynamic shunt compensation – Characteristic time periods – Passive shunt compensation – Static compensation-Series capacitor compensation – Compensation using synchronous condensers –Examples.

UNIT - III	**REACTIVE POWER COORDINATION & DEMAND SIDE MANAGEMENT**	Lecture Hrs: 12

Objective – Mathematical modeling – Operation planning – Transmission benefits – Basic concepts of quality of power supply – Disturbances - Steady – state variations – Effects of under Voltages – Frequency – Harmonics, radio frequency and electromagnetic interferences. Load patterns – Basic methods - load shaping – Power tariffs - KVAR based tariffs - penalties for voltage flickers and Harmonic voltage levels.

UNIT - IV	**DISTRIBUTION & USER SIDE REACTIVE POWER MANAGEMENT**	Lecture Hrs:12

System losses – Loss reduction methods – Examples – Reactive power planning – Objectives – Economics - Planning capacitor placement – Retrofitting of capacitor banks - KVAR requirements for domestic appliances – Purpose of using capacitors – Selection of capacitors – Deciding factors – Types of capacitors, characteristics and Limitations.

UNIT - V	**REACTIVE POWER MANAGEMENT IN ELECTRIC TRACTION SYSTEMS AND ARC FURNACES**	Lecture Hrs:10

Typical layout of traction systems – Reactive power control requirements – Distribution transformers - Electric arc furnaces – Furnaces transformer – Filter requirements – Remedial measures – Power factor of an arc furnace.

Textbooks:
1. T.J.E.Miller, "Reactive Power Control in Electric Systems", John Wiley and Sons, 5th edition, 2017. 2. D.M.Tagare, Reactive power Management, Tata Mc Graw Hill, 1st edition, 2004.
Reference Books:
1. Dr. Hidaia alassouli, "Reactive Power Compensation", Kindle Edition.2018. 2. Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just "Reactive Power Compensation: A Practical Guide, Wiely publication, 4th edition, April, 2012.

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**POWER QUALITY**	**L**	**T**	**P**	**C**
21D07204a	**(PE- IV)**	**3**	**0**	**0**	**3**
	Semester	**II**			

Course Objectives: To make the student

- To understand power quality definition, power quality standards.
- To remember measuring & solving power quality problems.
- To apply the various types of linear and nonlinear loads
- To analyse harmonic methodology, mitigation techniques and case study

Course Outcomes (CO): Student will be able to

- Understand the fundamentals & terminology of power quality.
- Apply the concept of power frequency disturbances, types of transients & transient waveforms.
- Analyze the harmonic methodology & Electromagnetic Interference concepts.
- Remember the necessity of grounding and methods of grounding.
- Understand different techniques of measuring & solving power quality problems

UNIT - I	**INTRODUCTION TO POWERQUALITY**	Lecture Hrs: 10

Definition of Power Quality - Power Quality Progression - Power Quality Terminology - Power Quality Issues– Responsibilities of Power Suppliers and Users-Power Quality Standards.

UNIT - II	**POWER FREQUENCY DISTURBANCE&TRANSIENTS**	Lecture Hrs: 8

Introduction to Power Frequency Disturbance - Common Power Frequency Disturbances – Characteristics of Low Frequency Disturbances - Voltage Tolerance Criteria- ITIC Graph - Introduction to Transients -Transient System Model - Examples of Transient Models and Their Response - Power System Transient Modeling-Types and Causes of Transients -Examples of Transient Waveforms.

UNIT - III	**HARMONICS & ELECTROMAGNETIC INTERFERENCE (EMI)**	Lecture Hrs: 12

Definition of Harmonics - Harmonic Number (h) - Odd and Even Order Harmonics - Harmonic Phase Rotation and Phase Angle - Voltage and Current Harmonics - Individual and Total Harmonic Distortion -Harmonic Signatures - Effect of Harmonics On Power System Devices - Guidelines For Harmonic Voltage and Current Limitation - Harmonic Current Mitigation - Introduction to EMI - Frequency Classification –Electrical Fields-Magnetic Fields-EMI Terminology-Power Frequency Fields-High Frequency Interference-EMI Susceptibility-EMI Mitigation-Cable Shielding-Health Concerns of EMI.

UNIT - IV	**GROUNDINGANDBONDING**	Lecture Hrs:12

Introduction to Grounding and Bonding-Shock and Fire Hazards-NEC Grounding Requirements-Essentials of a Grounded System-Ground Electrodes-Earth Resistance Tests-Earth Ground Grid Systems-Power Ground System-Signal Reference Ground(SRG)-SRG Methods-Single and Multipoint Grounding –Ground Loops – Electro chemical Reaction -Examples of Grounding Anomalies.

UNIT - V	**MEASURING AND SOLVING POWER QUALITY PROBLEMS**	Lecture Hrs:10

Introduction to Power Quality Measurements-Power Quality Measurement Devices-Power Quality Measurements Test Locations-Test Duration-Instrument Setup- Instrument Guidelines – Power quality mitigating concepts and devices .

Textbooks:
1. Power quality by C. Sankaran, CRC Press, 1st Edition, 2001 2. Electrical Power Systems Quality, Roger C. Dugan, Mark F. Mc Granaghan, Surya Santoso, H. Wayne Beaty, 2nd Edition, TMH Education Pvt. Ltd, 1996.
Reference Books:
1. Understanding Power quality problems by Math H. J.Bollen IEEE Press, 1st edition, 2000. 2. Power quality enhancement using custom power devices by Arindam, Ghosh, Gerard Ledwich, Kluwer, Academic publishers, 1st edition, 2002.

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	DISTRIBUTED GENERATION & MICROGRID CONTROL (PE– IV)	L	T	P	C
21D07204b		3	0	0	3
	Semester	II			

Course Objectives: To make the student

- Able to know about the concept of distributed generation, distribution network & the concept of Microgrid, its configuration, advantages & limitations.
- Able to understand the basic concepts in combined heat and power, Wind energy conversion systems, solar photovoltaic systems & other renewable energy sources.
- Able to analyze the impact of Microgrid & Active distribution network management system on various factors.
- Able to know the effect of SCADA & understand the concept of Power quality disturbances, improvement technologies & issues of premium power in DC integration.

Course Outcomes (CO): Student will be able to

- Understand the concept of distributed generation, distribution network & the concept of Microgrid, its configuration, advantages & limitations.
- Understand the basic concepts in combined heat and power, Wind energy conversion systems, Solar photovoltaic systems & other renewable energy sources.
- The impact of Microgrid & Active distribution network management system on various factors isknown.
- Understand the effect of SCADA & understand the concept of Power quality disturbances, improvement technologies & issues of premium power in DC integration.

UNIT - I	INTRODUCTION TO DISTRIBUTED GENERATION AND MICROGRIDCONCEPT	Lecture Hrs: 10

Introduction to distributed generation - Active distribution network - Concept of Microgrid - Microgrid configuration - Interconnection of Microgrids - Technical and economical advantages of Microgrid - Challenges and limitations of Microgrid development - Management and operational issues of a Microgrid - Dynamic interactions of Microgrid with main grid – low voltage DC grid.

UNIT - II	DISTRIBUTED ENERGY RESOURCES	Lecture Hrs: 8

Introduction - Combined heat and power (CHP) systems: Micro-CHP systems - Wind energy conversion systems (WECS): Wind turbine operating systems - Solar photovoltaic (PV) systems:Classification of PV cell - Small-scale hydroelectric power generation - Other renewable energy sources - Storage devices.

UNIT - III	MICROGRID AND ACTIVE DISTRIBUTION NETWORK MANAGEMENTSYSTEM	Lecture Hrs: 12

Introduction - Impact on heat utilization - Impact on process optimisation - Impact on market - Impact on environment - Impact on distribution system - Impact on communication standards and protocols - Network management needs of Microgrid - Microsource controller - Central controller.

UNIT - IV	SCADA AND ACTIVE DISTRIBUTION NETWORKS	Lecture Hrs:12

Introduction - Existing DNO SCADA systems - Control of DNO SCADA systems - SCADA in Microgrids - Human–machine interface (HMI) - Hardware components - Communication trends in SCADA - Distributed control system (DCS) - Sub-station communication standardization - SCADA communication and control architectures - Communication devices.

UNIT - V	**IMPACT OF DG INTEGRATION ON POWER QUALITY AND RELIABILITY**	Lecture Hrs:10
Introduction - Power quality disturbances - Power quality sensitive customers - Power quality improvement technologies - Impact of DG integration - Issues of premium power in DG integration.		
Textbooks:		
1. S. Chowdhury, S.P. Chowdhury and P. Crossley, "Microgrids and Active Distribution Networks", The Institution of Engineering and Technology, 2009. 2. Rajeev Kumar Chuahan, Kalpana Chuahan, "Distributed Energy Resources in Microgrids: Integration, Chalenges and Optimization", Academic Press, 1st Edition, 2019		
Reference Books:		
1. Magdi S. Mahmoud, "MICROGRID Advanced Control Methods and Renewable Energy System Integration", Joc Hayton, 1st Edition, 2016.		

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**EHVAC TRANSMISSION**	**L**	**T**	**P**	**C**
21D07204c	**(PE-IV)**	**3**	**0**	**0**	**3**
	Semester	**II**			

Course Objectives: To make the student

- To understand the basic concepts of EHVAC
- To Identify the factors affecting AC-DC transmission
- To analyze travelling waves and the effects of corona like audible noise
- To estimate field intensity at any point in EHV system with the help of different computational method

Course Outcomes (CO): Student will be able to

- Understand the basic concepts of EHVAC
- Identify the factors affecting AC-DC transmission
- Analyze travelling waves and the effects of corona like audible noise
- Estimate field intensity at any point in EHV system with the help of different computational method.

UNIT - I	**PRELIMINARIES**	Lecture Hrs: 10

Necessity of EHV AC transmission – Advantages and problems – Power handling capacity and line losses- Mechanical considerations – Resistance of conductors – Properties of bundled conductors – Bundle spacing and bundle radius - Examples.

UNIT - II	**LINE AND GROUND REACTIVE PARAMETERS**	Lecture Hrs: 8

Line inductance and capacitances – Sequence inductances and capacitances – Modes of propagation – Ground return – Examples. Electrostatics – Field of sphere gap – Field of line changes and properties – Charge – potential relations for multi-conductors – Surface voltage gradient on conductors – Distribution of voltage gradient on sub-conductors of bundle – Examples.

UNIT - III	**CORONA EFFECTS**	Lecture Hrs: 12

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 – Radio interference (RI) - Corona pulses generation, properties, limits – Frequency spectrum – Modes of propagation – Excitation function – Measurement of RI, RIV and excitation functions - Examples.

UNIT - IV	**ELECTROSTATIC FIELD & TRAVELING WAVE THEORY**	Lecture Hrs:12

Electrostatic field: calculation of electrostatic field of EHV/AC lines – Effect on humans, animals and plants – Electrostatic induction in un-energised circuit of double - circuit line – Electromagnetic interference - Examples. Traveling wave expression and solution - Source of excitation - Terminal conditions - Open circuited and short circuited end - Reflection and refraction coefficients - Lumped parameters of distributed lines - Generalized constants - No load voltage conditions and charging current.

UNIT - V	**VOLTAGE CONTROL**	Lecture Hrs:10

Power circle diagram and its use – Voltage control using synchronous condensers – Cascade connection of shunt and series compensation – Sub synchronous resonance in series capacitor – Compensated lines – Static VAR compensating system.

Textbooks:

1. Sanjay Kumar Sharma, "EHV-AC, HVDC Transmission and Distribution Engineering" 2nd Edition, 2016.
2. R. D. Begamudre, "EHVAC Transmission Engineering", New Age International (p) Ltd.2nd revised edition, 2012.
3. M. G. Dwek, EHV Transmission, Elsevier Sc., 3rd edition, 1992.

Reference Books:

1. R. Padiyar, HVDC Transmission Systems, Wiley Eastern Ltd., New Delhi, 2nd revised edition, 1992.
2. J. Arrilaga, High Voltage Direct Current Transmission, peter pereginver Ltd. London, U.K., 2nd edition, 1998.
3. E.W. Kimbark, Direct Current Transmission-vol.1, Wiley Inter science, New York , 1st edition, 1971

Online Learning Resources:

- https://www.ae.pwr.wroc.pl/filez/20110606092353_HEV.pdf
- https://www.afdc.energy.gov/pdfs/52723.pdf 5.https://www.leb.eei.uni
- langen.de/winterakademie/2010/report/content/course03/pdf/0308.pdf

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	**RENEWABLE ENERGY SYSTEMS LAB**	**L**	**T**	**P**	**C**
21D07205		**0**	**0**	**4**	**2**
	Semester	**II**			

Course Objectives: To make the student

- Understand how to write the coding in MATLAB/Mipower
- Apply the SVC,STATCOM for voltage profile improvements & UPFC in power system networks.
- Analyze the data related to load flows incorporating SVC & STATCOM.
- Analyze operation of TCSC, STATCOM & SSSC for a transmission line fed by an ac supply.

Course Outcomes (CO): Student will be able to

- To observe the I-V and P-V curves and Series and Parallel connection of Solar systems
- To study the sun tracking and MPPT Charge Controllers of Solar systems
- To analyze Power, Voltage & Frequency Measurement of Wind Generator
- To Understand the Effect of temperature variation and Irradiation on Photovoltaic Array

List of Experiments:

1. Draw the I-V and P-V curves of Solar Panel using PV Panel
2. Study of Series and Parallel connection of Solar Panels
3. Study of Sun tracking system
4. Maximum Power Point Tracking Charge Controllers
5. Inverter control for Solar PV based systems
6. Power, Voltage & Frequency Measurement of output of Wind Generator
7. Impact of load and wind speed on power output and its quality
8. Performance of frequency drop characteristics of induction generator at different loading condition
9. Charging and Discharging characteristics of Battery

Simulation Experiments

1. Modelling of PV Cell
2. Effect of temperature variation on Photovoltaic Array
3. Effect of Irradiation on a Photovoltaic Array
4. Design of solar PV boost converter using P&O MPPT technique

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

Note : Conduct any 7 experiments from 1-9 list and minimum 3 experiments from 1-4 of Simulation experiments

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	FACTS DEVICES & SIMULATION LAB	L	T	P	C
21D07206		0	0	4	2
	Semester	II			

Course Objectives: To make the student

- Understand how to write the coding in MATLAB/Mipower
- Apply the SVC,STATCOM for voltage profile improvements & UPFC in power system networks.
- Analyze the data related to load flows incorporating SVC & STATCOM.
- Analyze operation of TCSC, STATCOM & SSSC for a transmission line fed by an acsupply.

Course Outcomes (CO): Student will be able to

- Understand Load balancing using compensators.
- Apply load balancing using Compenasators.
- Analyse load flow incorporating SVC & STATCOM.
- Develop a Simulation model for STATCOM & UPFC.

List of Experiments:

1. Voltage regulation using shunt and series compensation
2. Load balancing in power system network using compensators
3. Simulation of TCSC
4. Voltage profile improvement using SVC
5. Voltage profile improvement using STATCOM
6. Transient Stability enhancement using STATCOM.
7. Simulation of UPFC with mathematical models
8. Load flow incorporating SVC
9. Load flow incorporating STATCOM
10. Simulation of DVR

11. Transmission Line Characteristics (P vs δ, Q vs δ, P vs Distance, Q vs Distance and V vsDistance) with and without Compensation

12. Sizing- simulation and operation of TCR and FC-TCR for a transmission line fed by an acsupply and feeding

(a) Resistive/inductive/capacitive load one at a time
(b) A load which can have leading as well as lagging behaviour

13. Sizing- simulation and operation of TCSC for a transmission line fed by an ac supply andfeeding

(c) Resistive/inductive/capacitive load one at a time
(d) A load which can have leading as well as lagging behaviour

14. Sizing- simulation and operation of STATCOM for a transmission line fed by an ac supplyand feeding

(e) Resistive/inductive/capacitive load one at a time
(f) A load which can have leading as well as lagging behaviour

15. Sizing- simulation and operation of SSSC for a transmission line fed by an ac supply and feeding

(g) Resistive/inductive/capacitive load one at a time
(h) A load which can have leading as well as lagging behaviour

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

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code	PEDAGOGY STUDIES	L	T	P	C
21DAC201a		2	0	0	0
	Semester	II			

Course Objectives: This course will enable students:

- Reviewexistingevidenceonthereviewtopictoinformprogrammedesignandpolicy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes (CO): Student will be able to

Students will be able to understand:

- Whatpedagogicalpracticesarebeingusedbyteachersinformalandinformalclassrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- Howcanteachereducation(curriculumandpracticum)andtheschoolcurriculumand guidance materials best support effective pedagogy?

UNIT - I

Introduction and Methodology: Aims and rationale, Policy back ground, Conceptual frame work and terminology Theories oflearning,Curriculum,Teachereducation.Conceptualframework,Research questions**.** Overview of methodology and Searching.

UNIT - II

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

UNIT - III

Evidence on theeffectivenessofpedagogicalpractices,Methodologyfortheindepthstage:quality assessmen t of included studies. How can teacher education (curriculumandpracticum) andthescho curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of th body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT - IV

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacherandthecommunity.Curriculumandassessment,Barrierstolearning:limitedresourcesand large class sizes

UNIT - V

Researchgapsandfuturedirections: Researchdesign**,**Contexts**,**Pedagogy**,**Teachereducation**,** Curriculum and assessment**,** Dissemination and research impact.

Suggested Reading

1. AckersJ,HardmanF(2001)ClassroominteractioninKenyanprimaryschools,Compare, 31 (2): 245-261.
2. AgrawalM(2004)Curricularreforminschools:Theimportanceofevaluation,Journalof
3. Curriculum Studies, 36 (3): 361-379.
4. AkyeampongK(2003) Teacher training in Ghana - does it count? Multi-site teachereducation research project (MUSTER) country report 1. London: DFID.
5. Akyeampong K, LussierK, PryorJ, Westbrook J (2013)Improving teaching and learning of basic maths and reading in Africa: Does teacherpreparation count?International Journal Educational Development, 33 (3): 272–282.
6. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
7. Chavan M (2003)ReadIndia: A mass scale, rapid, 'learning to read'campaign.
8. www.pratham.org/images/resource%20working%20paper%202.pdf.

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M.TECH. IN ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE & SYLLABI

Course Code		**L**	**T**	**P**	**C**
21DAC201b	**STRESSMANAGEMENT BY YOGA**	**2**	**0**	**0**	**0**
	Semester	**II**			
Course Objectives: This course will enable students:					
• To achieve overall health of body and mind • To overcome stres					
Course Outcomes (CO): Student will be able to					
• Develop healthy mind in a healthy body thus improving social health also • Improve efficiency					
UNIT - I					
Definitions of Eight parts of yog.(Ashtanga)					
UNIT - II					
Yam and Niyam.					
UNIT - III					
Do`sand Don't'sin life. i) Ahinsa,satya,astheya,bramhacharyaand aparigrahaii) Shaucha,santosh,tapa,swadhyay,ishwarpranidhan					
UNIT - IV					
Asan and Pranayam					
UNIT - V					
i)Variousyogposesand theirbenefitsformind &body ii)Regularizationofbreathingtechniques and its effects-Types ofpranayam					
Suggested Reading					
1.'Yogic Asanas forGroupTarining-Part-I": Janardan SwamiYogabhyasiMandal, Nagpur 2."Rajayogaor conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata					

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COURSE STRUCTURE & SYLLABI

Course Code	PERSONALITY DEVELOPMENT THROUGHLIFE ENLIGHTENMENTSKILLS	L	T	P	C
21DAC201c		2	0	0	0
	Semester	II			

Course Objectives: This course will enable students:

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Course Outcomes (CO): Student will be able to

- StudyofShrimad-Bhagwad-Geetawillhelpthestudentindevelopinghispersonalityand achieve the highest goal in life
- The person who has studied Geetawilllead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students

UNIT - I

Neetisatakam- Holistic development of personality Verses-19,20,21,22(wisdom)
Verses-29,31,32(pride &heroism) Verses-26,28,63,65(virtue)

UNIT - II

Neetisatakam- Holistic development of personality
Verses-52,53,59(dont's)
Verses-71,73,75,78(do's)

UNIT - III

Approach to day to day work and duties.
ShrimadBhagwadGeeta:Chapter2-Verses41,47,48,
Chapter3-Verses13,21,27,35,Chapter6-Verses5,13,17,23,35,
Chapter18-Verses45,46,48.

UNIT - IV

Statements of basic knowledge.
ShrimadBhagwadGeeta:Chapter2-Verses 56,62,68
Chapter12 -Verses13,14,15,16,17,18
Personality of Rolemodel. Shrimad Bhagwad Geeta:

UNIT - V

Chapter2-Verses 17,Chapter3-Verses36,37,42,
Chapter4-Verses18,38,39
Chapter18– Verses37,38,63

Suggested Reading

1. "SrimadBhagavadGita"bySwamiSwarupanandaAdvaitaAshram(PublicationDepartment), Kolkata
2. Bhartrihari'sThree Satakam (Niti-sringar-vairagya) by P.Gopinath, RashtriyaSanskrit Sansthanam, New Delhi.