J.B. INSTITUTE OF ENGINEERING AND TECHNOLOGY
(UGC AUTONOMOUS)
Bhaskar Nagar, Moinabad Mandal, R.R. District, Hyderabad -500075

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
M. Tech - ELECTRICAL POWER SYSTEMS (EPS): R-24

CHOICE BASED CREDIT SYSTEM (CBCS)
COURSE STRUCTURE (2024-2025)

I YEAR – I SEMESTER							
Sl. No	**Code**	**Core/ Elective**	**Course Title**	**L**	**T**	**P**	**C**
1.	MM21A	Core1	Advanced Power System Analysis	3	0	0	3
2.	MM21B	Core2	FACTS and Custom Power Devices	3	0	0	3
3.	MM21C MM21D MM21E	PE 1	1. Energy Auditing Conservation & Management 2. Smart-Grids 3. EHVAC Transmission	3	0	0	3
4.	MM21F MM21G MM21H	PE 2	1. Electrical Power Distribution System 2. Industrial Power System Analysis and Design 3. Distribution Automation	3	0	0	3
5.	MM211	Lab1	Electrical Simulation Lab -1	0	0	4	2
6.	MM212	Lab2	Power Systems Lab - 1	0	0	4	2
7.	MM91A	MC-I	Soft Skills & Personality Development	2	0	0	0
TOTAL CREDITS				14	0	8	**16**

I YEAR – II SEMESTER							
Sl. No	**Code**	**Core/ Elective**	**Course Title**	**L**	**T**	**P**	**C**
1.	MM22A	Core3	Advanced Power System Protection	3	0	0	3
2.	MM22B	Core4	Power System Operation and Deregulation	3	0	0	3
3.	MM22C MM22D MM22E	PE 3	1. High Voltage Engineering 2. Power Quality 3. HVDC Transmission	3	0	0	3
4.	MM22F MM22G MM22H	PE 4	1. Voltage Stability 2. AI Techniques in Electrical Engineering 3. Reactive Power Compensation and Management	3	0	0	3
5.	MM92A	Core	Research Methodology and IPR	2	0	0	2
6.	MM221	Lab3	Electrical Simulation Lab - 2	0	0	4	2
7.	MM222	Lab4	Power Systems Lab - 2	0	0	4	2

8.	MM92B	MC-II	Professional Value and Ethics	2	0	0	0
TOTAL CREDITS				16	0	8	**18**

II YEAR – I SEMESTER							
Sl. No.	**Code**	**Core/ Elective**	**Course Title**	**L**	**T**	**P**	**C**
1.	MM23A MM23B MM23C	PE 5	1. Electric Vehicles and Power Management 2. Modern Control Theory 3. Distributed Generation and Micro Grid	3	0	0	3
2.	MM2OB MM2OB	OE	1. Renewable Energy Technologies and Battery Storage 2. Solar and Energy Storage Systems	3	0	0	3
3.	MM231		Mini Project	0	0	4	2
4.	MM232		Technical Seminar	0	0	2	1
5.	MM233	Major Project	Phase-I Dissertation	0	0	20	09
TOTAL CREDITS				6	0	26	**18**
II YEAR – II SEMESTER							
Sl. No.	**Code**	**Core/ Elective**	**Course Title**	**L**	**T**	**P**	**C**
1.	MM241	Major Project	Phase-II Dissertation	0	0	32	16
TOTAL CREDITS				0	0	32	**16**
GRAND TOTAL CREDITS 68							

PE: Program Elective

OE: Open Elective

Open Elective-I

S. No.	Code	Course Title	L	T	P	D	Credits	Category	Common Subject (Y/N)
1	MM3OA	Disaster Management	3	0	0	0	3	OEC	CE
2	MM3OB	Precast &Prefabricated Construction	3	0	0	0	3	OEC	CE
3	MM6OA	Clean Room Technology and Maintenance.	3	0	0	0	3	OEC	ECE
4	MM6OB	Principles of Computer Communications and Networks.	3	0	0	0	3	OEC	ECE
5	MM2OA	Renewable Energy Technologies and Battery Storage	3	0	0	0	3	OEC	EEE
6	MM2OB	Solar and Energy Storage Systems	3	0	0	0	3	OEC	EEE
7	MM1OA	Industrial Safety	3	0	0	0	3	OEC	MECH
8			3	0	0	0	3	OEC	CSE
9			3	0	0	0	3	OEC	CSE

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year - I Sem			
Course Code: LM21A	CORE 1: ADVANCED POWER SYSTEM ANALYSIS	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Computer Methods in Power Systems

Module 1: Formation of Y_{BUS} [9L]

Unit-I: [5L]

Admittance model and network calculations, Branch and node admittances, mutually coupled branches in Y_{BUS}, An equivalent admittance network, Modification of Y_{BUS}.

Unit-II: [4L]

Network incidence matrix and Y_{BUS}, Method of successive elimination, Node elimination, Triangular factorization, Sparsity and near optimal ordering.

Module 2: Formation of Z_{BUS} [9L]

Unit-I: [4L]

Impedance model and network calculations, Bus admittance and impedance matrices, Thevenin's Theorem and Z_{BUS}

Unit-II: [5L]

Algorithms for building Z_{BUS} modification of existing Z_{BUS}, Calculation of Z_{BUS} elements from Y_{BUS}, Power invariant transformations, Mutually Coupled Branches in Z_{BUS}.

Module 3: Load Flow Analysis [8L]

Unit-I: [4L]

Gauss Seidel method and N-R Method.

Unit-II: [4L]

Decoupled method Fast decoupled method, Comparison between power flow solutions, DC load flow.

Module 4: Contingency Analysis [9L]

Unit-I: [5L]

Z_{BUS} method in Contingency Analysis, Adding and removing multiple lines, Piece-wise solution of interconnected Systems.

Unit-II: [4L]

Analysis of single contingencies, Analysis of multiple contingencies, Contingency analysis of DC Model, System reduction for contingency and fault studies.

Module 5: Fault Analysis [9L]

Unit-I: [5L]

Symmetrical faults, Fault calculations using Z_{BUS}, Fault calculations using Z_{BUS} equivalent circuits.

Unit-II: [4L]

Selection of circuit breakers, Unsymmetrical faults, Problems on various types of faults.

Text Books

1. Pai M A, "Computer Techniques in Power System Analysis", Tata McGraw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.
2. HadiSaadat, "Power System Analysis", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ ADVANCED POWER SYSTEM ANALYSIS.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ ADVANCED POWER SYSTEM ANALYSIS.
4. https://nptel.ac.in/courses.

Course Outcomes

Upon the completion of the subject, the student will be able to

CO 1. Construct network bus admittance matrix using successive elimination, node elimination, and triangular factorization.

CO 2. Construct network bus impedance matrix using Y_{BUS}, bus building algorithm and power invariant transformations with mutually coupled branches.

CO 3. Solve Load Flow problem using Gauss Seidal, N-R and FDLF methods.

CO 4. Analyze single contingency and multiple contingencies using Z_{BUS} method.

CO 5. Make use of Z_{BUS} for symmetrical and unsymmetrical fault calculations.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	1	2
CO2	2	3	3	2	2	2
CO3	3	3	3	3	2	2
CO4	3	3	3	3	2	2
CO5	3	3	3	2	2	2
Average	2.6	3	3	2.4	1.8	2

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems & Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21B	**CORE 2: FACTS and Custom Power Devices**	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power Electronics and Power Systems

Module 1: FACTS Concepts [9L]

Unit-I: [4L]

Reactive Power Flow Control in Power Systems: Power flow control, Constraints of maximum transmission line loading, Benefits of FACTS.

Unit-II: [5L]

Transmission line compensation, Uncompensated line, Shunt compensation, Series compensation, Phase angle control, Reactive power compensation, Shunt and Series compensation principles, Reactive compensation at transmission and distribution level.

Module 2: Static Shunt Compensation [9L]

Unit-I: [4L]

Static versus passive VAR compensator, Static shunt compensators.

Unit-II: [5L]

SVC and STATCOM, Operation and control of TSC, TCR and STATCOM Compensator control, Comparison between SVC and STATCOM.

Module 3: Static Series Compensation [8L]

Unit-I: [4L]

TSSC, SSSC -Static voltage and phase angle regulators, TCVR and TCPAR Operation and Control, Applications.

Unit-II: [4L]

Static series compensation, GCSC, TSSC, TCSC and Static synchronous series compensators and their Control.

Module 4: Combined Power Flow Controller [9L]

Unit-I: [4L]

Circuit Arrangement, Operation and control of UPFC.

Unit-II: [5L]

Basic Principle of P and Q control, Independent real and reactive power flow control-Applications, Introduction to interline power flow controller (IPFC)

Module 5: Custom Power Devices [9L]

DSTATCOM - Schematic Diagram and Operation, Topologies - DVR - Schematic Diagram and Operation, Topologies – Applications.

Text Books

1. K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International Publishers, 2007.
2. 2. N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001

E-Resources

1. https://www.sciencedirect.com/topics/engineering/flexible-ac-transmission-systems.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/facts-on-facts-theory-and-applications.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO1. Distinguish the performance of Transmission lines with and without FACTS Devices

CO2. Compare the SVC and STATCOM

CO3. Understand the operation and control of various Static Series Compensators

CO4. Understand the operation and control of the Unified Power Flow Controller

CO5. Summarize the operation and topologies of various Custom Power Devices.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to

solve practical problems.

2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21C	PROGRAM ELECTIVE 1: ENERGY AUDITING, CONSERVATION AND MANAGEMENT	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Electrical Distribution Systems

Module 1: Basic principles of energy audit [9L]

Unit-I: [4L]

Energy audit- Definitions, Concept, Types of audit, Energy index, Cost index, Pie charts, Sankey diagrams, Load profiles.

Unit-II: [5L]

Energy conservation schemes - Energy audit of industries- Energy saving potential, Energy audit of process industry, Thermal power station and Building energy audit.

Module 2: Energy management [9L]

Unit-I: [4L]

Principles of energy management and organizing energy management program**.**

Unit-II: [5L]

Initiating, Planning, Controlling, Promoting, Monitoring, Reporting, Energy manger, Qualities and functions, Language, Questionnaire–Check list for top management.

Module 3: Energy efficient motors [9L]

Unit-I: [5L]

Energy efficient motors, Factors affecting efficiency, Loss distribution and Constructional details.

Unit-II: [4L]

Characteristics - Variable speed, Variable duty cycle systems, RMS HP- Voltage variation- Voltage unbalance- Over motoring- Motor energy audit.

Module 4: Power factor improvement, lighting and energy instruments [9L]

Unit-I: [4L]

Power factor–Methods of improvement, Location of capacitors, Pf with non-linear loads, Effect of harmonics on power factor.

Unit-II: [5L]

Power factor motor controllers - Good lighting system design and practice, Lighting control , Lighting energy audit - Energy instruments- Wattmeter, Data loggers, Thermocouples,

Pyrometers, Lux meters, Tongue testers, Application of PLC's.

Module 5: Economic aspects and analysis [9L]

Unit-I: [5L]

Economics analysis-Depreciation methods, Time value of money, Rate Of return, Present worth method, Replacement analysis, Life cycle costing analysis- Energy efficient motors**.**

Unit-II: [4L]

Calculation of simple payback method, Net present worth method- Power factor correction, Lighting -Applications of life cycle costing analysis, Return on investment.

Text Books

1. W.R. Murphy& G. Mckay,"Energy Management" Butter worth, HeinemannPublications, Second Edition, 2009.
2. Paul o' Callaghan, "Energy Management", Tata Mc-Graw Hill Book Company- FirstEdition, 1998.
3. W.C.Turner, "Energy Management Hand Book", CRC Press, First Edition, 2004.

E-Resources

1) https://www.sciencedirect.com/topics/engineering/ENERGY-AUDITING-CONSERVATION-AND MANAGEMENT.
2) https://digital-library.theiet.org/content/books/po/pbpo030e.
3) https://www.electrical4u.com/facts-on-EACM-theory-and-applications.
4) https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Tell energy audit of industries.

CO 2. Predict management of energy systems.

CO 3. Sequence the methods of improving efficiency of electric motor.

CO 4. Analyze the power factor and to design a good illumination system.

CO 5. Determine pay back periods for energy saving equipment.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1

CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21D	PROGRAM ELECTIVE 1: SMART GRID	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power system - II

Module 1: Introduction to smart grid [9L]

Unit-I: [4L]

Electricity network-Local energy networks- Electric transportation- Low carbon central generation-Attributes of the smart grid- Alternate views of a smart grid.

Unit-II: [5L]

Smart grid to evolve a perfect power system: Introduction- Overview of the perfect power system configurations- Device level power system- Building integrated power systems- Distributed power systems- Fully integrated power system-Nodes of innovation.

Module 2: DC distribution and smart grid [9L]

Unit-I: [4L]

AC vs DC sources-Benefits of and drives of DC power delivery systems-Powering equipment and appliances with DC-Data centers and information technology loads-Future neighbourhood-Potential future work and research.

Unit-II: [5L]

Intelligrid architecture for the smart grid: Introduction- Launching intelligrid - Intelligrid today- Smart grid vision based on the intelligrid architecture-Barriers and enabling technologies.

Module 3: Dynamic Energy Systems Concept [8L]

Unit-I: [4L]

Smart energy efficient end use devices - Smart distributed energy resources - Advanced whole building control systems - Integrated communications architecture-Energy management.

Unit-II: [4L]

Role of technology in demand response - Current limitations to dynamic energy management - Distributed energy resources-Overview of a dynamic energy management - Key characteristics of smart devices- Key characteristics of advanced whole building control systems-Key characteristics of dynamic energy management system.

Module 4: Energy port as part of the smart grid [9L]

Unit-I: [5L]

Concept of energy-Port, Generic features of the energy port. Policies and programs to encourage end–Use energy efficiency: Policies and programs in action -Multinational – National – State-City and corporate levels.

Unit-II: [4L]

Market implementation: Framework - Factors influencing customer acceptance and response - program planning-monitoring and evaluation.

Module 5: Efficient Electric End – Use Technology Alternatives [9L]

Unit-I: [5L]

Existing technologies – lighting - Space conditioning - Indoor air quality - Domestic water heating- hyper efficient appliances - Ductless residential heat pumps and air conditioners – Variable refrigerant flow air conditioning-Heat pump water heating - Hyper efficient residential appliances.

Unit-II: [4L]

Data center energy efficiency- LED street and area lighting - Industrial motors and drives - Equipment retrofit and replacement - Process heating - Cogeneration, Thermal energy storage -Industrial energy management programs - Manufacturing process-Electro-technologies, Residential, Commercial and industrial sectors.

Text Books

1. Clark W Gellings, "The Smart Grid, Enabling Energy Efficiency and Demand Side Response", CRC Press, 2009.
2. JanakaEkanayake, KithsiriLiyanage, Jianzhong. Wu, Akihiko. Yokoyama, Nick Jenkins, "Smart Grid: Technology and Applications"- Wiley, 2012.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/SMART-GRID.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/SMART GRID.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Apply the concepts of smart grid architecture, dynamic energy systems, energy port in real time applications Integration of smart devices for substation automation.

CO 2. Apply smart grid policies and programs to encourage end – use energy efficiency.

CO 3. Explore the SCADA communication systems.

CO 4. Extend knowledge of substation automation functions and benefits of data warehousing.

CO 5. Interpret the load forecasting and transmission operations and management in real time applications.

CO 6. Integrate DMS framework and real time DMS applications.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21E	PROGRAM ELECTIVE 1: EHV AC TRANSMISSION	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power Systems - II

Module 1: E.H.V.A.C [9L]

Unit-I: [4L]

Transmission line trends and preliminary aspect standard transmission voltages –Estimation at line and ground parameters

Unit-II: [5L]

Bundle conductor systems-Inductance and Capacitance of E.H.V. lines – Positive, negative and zero sequence impedance – Line Parameters for modes of propagation.

Module 2: Electrostatic field and voltage gradients [9L]

Unit-I: [4L]

Calculations of electrostatic field of AC lines – Effect of high electrostatic field on biological organisms and human beings.

Unit-II: [5L]

Surface voltage gradients and maximum gradients of actual transmission lines – Voltage gradients on sub conductor.

Module 3: Electrostatic induction in unenergized lines [8L]

Unit-I: [4L]

Measurement of field and voltage gradients for three phase single, double circuit lines – Unenergized lines.

Unit-II: [4L]

Power frequency voltage control and over-voltages in EHV lines: No load voltage – Charging currents at power frequency-Voltage control – Shunt and series compensation – Static VAR compensation.

Module 4: Corona in E.H.V. lines [9L]

Unit-I: [5L]

Corona loss formulae, Attenuation of travelling waves due to corona, Audio noise due to corona, its generation, Characteristic and limits.

Unit-II: [4L]

Measurements of audio noise radio interference due to corona - Properties of radio noise – Frequency spectrum of RI fields –Measurements of RI and RIV.

Module 5: Design of EHV lines [5L]

Unit-I: [5L]

Based on steady state and transient limits, EHV cables and their characteristics.

Text Books

1. R. D. Begamudre, "EHVAC Transmission Engineering", New Age International (p) Ltd, Revised Third Edition, 2006.
2. S. Rao, "HVAC and DC Transmission", Khanna Publishers, New Delhi, Third Edition.
3. Subir Ray, "An Introduction to High Voltage Engineering", Prentice Hall of India Private Limited, Seventh Printing, Second Edition, 2013.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ EHV AC TRANSMISSION.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ EHV AC TRANSMISSION.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. List the necessity of EHV AC transmission, choice of voltage for transmission, line losses and power handling capability.

CO 2. Estimate the Statistical procedures for line designs, scientific and engineering principles in power systems.

CO 3. Construct commercial transmission system.

CO 4. Knowledge on Corona in E.H.V. lines.

CO 5. Knowledge on Design of EHV lines.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21F	PROGRAM ELECTIVE – 2: ELECTRIC POWER DISTRIBUTION SYSTEM	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Electric Distribution Systems

Module 1: Distribution of power [9L]

Unit-I: [4L]

Distribution of power, Management, Power loads**.**

Unit-II: [5L]

Load forecasting short-term & long-term, power system loading, Technological forecasting.

Module 2: Advantages of Distribution Management System (D.M.S.) Distribution automation [9L]

Unit-I: [4L]

Advantages of Distribution Management System (D.M.S.) Distribution automation, Definition, Restoration / Reconfiguration of distribution network**.**

Unit-II: [5L]

Different methods and constraints power factor correction.

Module 3: Interconnection of distribution, control & communication systems [8L]

Unit-I: [4L]

Interconnection of distribution, control & communication systems, remote metering, Automatic meter reading and its implementation.

Unit-II: [4L]

SCADA: Introduction, Block Diagram, SCADA applied to distribution automation, Common functions of SCADA, Advantages of distribution automation through SCADA.

Module 4: Calculation of optimum number of switches [9L]

Unit-I: [4L]

Calculation of optimum number of switches, Capacitors, Optimum switching device placement in radial and Distribution systems**.**

Unit-II: [5L]

Sectionalizing switches – Types, Benefits, Bellman's optimality principle, Remote terminal units, Energy efficiency in electrical distribution & monitoring.

Module 5: Maintenance of automated distribution systems [9L]

Unit-I: [5L]

Maintenance of automated distribution systems, Difficulties in implementing distribution

Unit-II: [4L]

Automation in actual practice, Urban/Rural distribution, Energy management, AI techniques applied to distribution automation.

Text Books

1. A.S. Pabla, "Electric Power Distribution", Tata McGraw Hill Publishing Co. Ltd., New Delhi, Sixth Edition, 2017.
2. M.K. Khedkar, G.M. Dhole, "A Text Book of Electrical Power Distribution Automation", University Science Press, New Delhi, First Edition, 2010.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ELECTRIC-POWER-DISTRIBUTION SYSTEM.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ ELECTRIC POWER DISTRIBUTION SYSTEM.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Knowledge of power distribution system.
CO 2. Study of distribution automation and its application in practice.
CO 3. Learn SCADA system.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	2	1
CO2	3	-	3	3	2	1
CO3	3	-	3	3	2	1
Average	3	-	3	3	2	1

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the

specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.

4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21G	PROGRAM ELECTIVE – 2: INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites:

Module 1: Motor Starting Studies [9L]

Unit-I: [4L]

Introduction: Evaluation Criteria - Starting Methods - System Data-Voltage Drop Calculations**.**

Unit-II: [5L]

Calculation of Acceleration Time - Motor Starting with Limited-Capacity Generators– Computer - Aided Analysis - Conclusions.

Module 2: Power Factor Correction Studies [9L]

Unit-I: [4L]

Introduction: System Description and Modeling-Acceptance Criteria-Frequency Scan Analysis – Voltage Magnification Analysis**.**

Unit-II: [5L]

Sustained Overvoltage's, Switching Surge Analysis, Back-to-Back Switching - Summary and Conclusions.

Module 3: Harmonic Analysis [9L]

Unit-I: [4L]

Harmonic Sources-System Response to Harmonics-System Model for Computer-Aided Analysis

Unit-II: [5L]

Acceptance Criteria, Harmonic Filter, Harmonic Evaluation, Case Study, Summary and Conclusions.

Module 4: Flicker Analysis [9L]

Unit-I: [4L]

Sources of Flicker, Flicker Analysis and Flicker Criteria**.**

Unit-II: [5L]

Data for Flicker analysis: Case Study-Arc Furnace Load-Minimizing the Flicker Effects-Summary.

Module 5: Insulation and Coordination [9L]

Unit-I: [5L]

Modelling of system; simulation of switching surges; description of EMTP – capabilities

Unit-II: [4L]

Voltage acceptance criteria, insulation coordination case study, methods of minimizing switching transients and conclusions.

Text Books

1. Ramasamy Natarajan, "Computer-Aided Power System Analysis", Marcel Dekker Inc., 2002.
2. EMTP literature from www.microtran.cm
3. IEEE papers on bus transfer.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/INDUSTRIAL-POWER-SYSTEM-ANALYSIS AND DESIGN.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Learners will have knowledge on motor starting and power factor correction.

CO 2. Learners will perform computer-aided harmonic and flicker analysis and to design filters.

CO 3. Learners will have knowledge on various grid grounding methodologies

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.

2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21H	PROGRAM ELECTIVE – 2: DISTRIBUTION AUTOMATION	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Electrical Distribution Systems

Module 1: Distribution automation and the utility system [9L]

Unit-I: [4L]

Introduction to distribution automation (DA), Control system interfaces, Control and data requirements**.**

Unit-II: [5L]

Centralized vs decentralized control, DA System (DAS), DA hardware, DAS software.

Module 2: Distribution automation functions [9L]

Unit-I: [4L]

DA capabilities, Automation system computer facilities, Management processes, Information management

Unit-II: [5L]

System reliability management, System efficiency management, Voltage management and Load management.

Module 3: Communication systems for DA [9L]

Unit-I: [4L]

DA communication requirements, Communication reliability, Cost effectiveness, Data rate requirements, Two way capability, Ability to communicate during outages and faults, Ease of operation and maintenance, Conforming to the architecture of data flow.

Unit-II: [5L]

Communication systems used in DA: Distribution line carrier (Power line carrier), Ripple control, Zero crossing technique, telephone, cable TV, Radio, AM broadcast, FM SCA, VHF Radio, UHF Radio, Microwave satellite, Fiber optics, Hybrid communication systems, Communication systems used in field tests.

Module 4: Technical Benefits [9L]

Unit-I: [4L]

DA benefit categories, Capital deferred savings, Operation and maintenance savings, Interruption related savings, Customer related savings, Operational savings, improved

operation, Function benefits, Potential benefits for functions, and function shared benefits.

Unit-II: [5L]

Guidelines for formulation of estimating equations, Parameters required, Economic impact areas, Resources for determining benefits impact on distribution system, Integration of benefits into economic evaluation.

Module 5: Economic evaluation methods [9L]

Unit-I: [5L]

Development and evaluation of alternate plans, Select study area, Select study period, Project load growth, Develop alternatives, Calculate operating and maintenance costs, Evaluate alternatives. Economic comparison of alternate plans, Classification of expenses and capital expenditures.

Unit-II: [4L]

Comparison of revenue requirements of alternative plans, Book life and continuing plant analysis, Year by year revenue requirement analysis, Short term analysis, End of study adjustment, Break even analysis, Sensitivity analysis computational aids.

Text Books

1. James. Northcote – Green Robert Wilson, "Control and Automation of Electrical Distribution Systems", CRC Press, First Edition, 2007.
2. Biswarup Das, "Power Distribution Automation", Institution of Engineering and Technology (IET) Publishers, Volume 2, 2016.
3. James A. Momoh, "Electric Power Distribution, Protection and Control", CRC Press, First Edition, 2007.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/DISTRIBUTION AUTOMATION.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ DISTRIBUTION AUTOMATION.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Find the transfer of electrical data in distribution system through digital communication.

CO 2. Predict load forecasting and reliability in economic point of view.

CO 3. Apply distribution automation objectives and SCADA.

CO 4. Have knowledge on management of different electrical parameters.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1
Average	3	-	3	3	-	1

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21I	LABORATORY – 1: ELECTRICAL SIMULATION LAB-1	L	T	P	C
Credits: **2**		**0**	**0**	**4**	**2**

List of the Experiments:

1. Simulation program for Y_{BUS} formation.
2. Simulation program for G-S load flow analysis.
3. Simulation program for N-R load flow analysis.
4. Simulation program for FDLF load flow analysis.
5. Simulation program for short circuit analysis.
6. Transient stability analysis for single machine connected to infinite bus by point by point method.
7. Simulation program for generation system reliability analysis.
8. Simulation program for distribution system reliability analysis.
9. Simulink model for a single area load frequency problem and simulate the same.
10. Simulink model for a two area load frequency problem and simulate the same.

Course Outcomes

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

CO 1. Understand/simulate/analyse power system analysis using software.

CO 2. Models of power systems and power electronics.

CO 3. Programs of power system reliability and power electronics.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**3**	**3**	**2**	**1**
CO2	**3**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**3**	**3**	**3**	**2**	**1**
Average	**3**	**3**	**3**	**3**	**2**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21J	LABORATORY – 2: POWER SYSTEMS LAB – I	L	T	P	C
Credits: **2**		**0**	**0**	**4**	**2**

List of the Experiments:

1. Determination of sequence impedance of cylindrical rotor synchronous machine.
2. Single line to ground fault (L-G) analysis of cylindrical rotor synchronous machine.
3. Line to line fault (L-L) analysis of cylindrical rotor synchronous machine.
4. Double line to ground fault (L-L-G) analysis of cylindrical rotor synchronous machine.
5. Triple line to ground fault (L-L-L-G) analysis of cylindrical rotor synchronous machine.
6. Determination of sub-transient reactance of a salient pole synchronous machine.
7. Power angle characteristics of salient pole alternator.
8. Demonstrate I-V and P-V Characteristics of PV Module with varying radiations and temperature level.
9. Demonstrate I-V and P-V Characteristics of PV Module with series and parallel combination.
10. Determination of Variation in Tilt Angle on PV Module.

Course Outcomes

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

CO 1. Have knowledge on short circuit analysis.

CO 2. Ability to conduct experiments on synchronous machine to find the characteristics.

CO 3. Able to understand the performance evaluation of various solar equipment's.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to

solve practical problems.

2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

J.B INSTITUTE OF ENGINEERING & TECHNOLOGY (UGC Autonomous)			
M. Tech.	**L**	**T-P-D**	**C**
I Year - I Semester	**3**	**0-0-0**	**0**

SOFT SKILLS& PERSONALITY DEVELOPMENT
(Mandatory Course – I)

Course Objectives:

This course will enable students to:

1. Study the Positivity, Motivation and developing positive thinking and attitude.
2. Summarize the listening skills and essential formal writing skills.
3. Explain theTime Management and Personality Development.
4. Describe the Decision-Making and Problem-Solving Skills.
5. Study the Psychometric Analysis and Mock Interview Sessions.

UNIT-I:Soft Skills: An Introduction – Definition and Significance of Soft Skills; Process, Importance and Measurement of Soft Skill Development. Self-Discovery: Discovering the Self; Setting Goals; Beliefs, Values, Attitude, Virtue. Positivity and Motivation: Developing Positive Thinking and Attitude; Driving out Negativity; Meaning and Theories of Motivation; Enhancing Motivation Levels.

UNIT-II: Interpersonal Communication: Interpersonal relations; communication models, process, and barriers; team communication; developing interpersonal relationships through effective communication; listening skills; essential formal writing skills; corporate communication styles – assertion, persuasion, negotiation.Public Speaking: Skills, Methods, Strategies and Essential tips for effective public speaking. Group Discussion: Importance, Planning, Elements, Skills assessed; Effectively disagreeing, Initiating, Summarizing and Attaining the Objective.

Non-Verbal Communication: Importance and Elements; Body Language.Teamwork and Leadership Skills: Concept of Teams; Building effective teams; Concept of Leadership and honing Leadership skills.

UNIT-III: Interview Skills: Interviewer and Interviewee – in-depth perspectives. Before, During and After the Interview. Tips for Success. Presentation Skills: Types, Content, Audience Analysis, Essential Tips – Before, During and After, Overcoming Nervousness. Etiquette and Manners – Social and Business.Time Management – Concept, Essentials, Tips.Personality Development – Meaning, Nature, Features, Stages, Models; Learning Skills; Adaptability Skills.

UNIT-IV: Decision-Making and Problem-Solving Skills: Meaning, Types and Models, Group and Ethical Decision-Making, Problems and Dilemmas in application of these skills. Conflict Management: Conflict - Definition, Nature, Types and Causes; Methods of Conflict Resolution. Stress Management: Stress - Definition, Nature, Types, Symptoms and Causes; Stress Analysis Models and 8 Impact of Stress; Measurement and Management of Stress, Leadership and Assertiveness Skills: A Good Leader; Leaders and Managers; Leadership Theories; Types of Leaders; Leadership Behaviour; Assertiveness Skills.Emotional Intelligence: Meaning, History, Features, Components, Intrapersonal and Management Excellence; Strategies to enhance Emotional Intelligence.

UNIT-V: Employability Skills: Resume Buildings – Facing the Personal Interview (HR and Technical)- Psychometric Analysis- Mock Interview Sessions.

REFERENCES:

1. Managing Soft Skills for Personality Development –edited by B.N.Ghosh, McGraw Hill

India, 2012.

2. English and Soft Skills – S.P.Dhanavel, Orient BlackswanIndia, 2010.

Course outcomes:

On completion of the course, the students will be able to:

1. Describe the Positivity, Motivation and developing positive thinking and attitude.
2. Explain the listening skills and essential formal writing skills.
3. Discuss theTime Management and Personality Development.
4. Illustrate the Decision-Making and Problem-Solving Skills.
5. Describe the Psychometric Analysis and Mock Interview Sessions.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22A	CORE 3: ADVANCED POWER SYSTEM PROTECTION	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Switch Gear and Protection.

Module 1: Static relays [9L]

Unit-I: [4L]

Advantages of 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 comparators.

Unit-II: [5L]

Amplitude comparators: Circulating current type and opposed voltage type, Rectifier bridge comparators, Direct and instantaneous comparators.

Module 2: Phase comparators [9L]

Unit-I: [4L]

Coincidence circuit type- block spike phase comparator, techniques to measure the period of coincidence, Integrating type, Rectifier and Vector product type, Phase comparators.

Unit-II: [5L]

Static over current relays: Instantaneous over current relay, Time over current relays, Basic principles, definite time and inverse definite time over-current relays.

Module 3: Static differential relays [9L]

Unit-I: [4L]

Analysis of static differential relays, Static relay schemes, Duo bias transformer differential protection, Harmonic restraint relay.

Unit-II: [5L]

Static distance relays: Static impedance-reactance, MHO and angle impedance relay, Sampling comparator, Realization of reactance and MHO relay using sampling comparator.

Module 4: Multi-input comparators [9L]

Unit-I: [4L]

Conic section characteristics, Three input amplitude comparator, Hybrid comparator, switched distance schemes, Poly phase distance schemes, phase fault scheme, three phase scheme,

combined and ground fault scheme.

Unit-II: [5L]

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.

Module 5: Microprocessor based protective relays [9L]

Unit-I: [5L]

(Block diagram and flowchart approach only), Over current relays– Impedance relays – Directional relay-reactance relay. Generalized mathematical expressions for distance relays, measurement of resistance and reactance.

Unit-II: [4L]

MHO and offset MHO relays, Realization of MHO characteristics, Realization of offset MHO characteristics, Basic principle of Digital computer relaying.

Text Books

1. Badri Ram and D.N.Vishwakarma, "Power system protection and Switch gear", Tata McGraw Hill Publication, New Delhi, 1995.
2. T.S.Madhava Rao, "Power system protection: Static relays", Tata McGraw Hill Publication, New Delhi, Second edition, 1989.

E-Resources

1. Https://www.sciencedirect.com/topics/engineering/ advanced power system protection.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ADVANCED-POWER SYSTEM AND PROTECTION.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Understand the basic function of a circuit breaker, all kinds of circuit breakers and differentiate fuse and circuit breakers under fault condition.

CO 2. Describe the necessity for the protection of alternators, transformers and feeder bus bars from over voltages and other hazards.

CO 3. Illustrate neutral grounding, and how over voltages can be generated and how system can be protected against lightning and switching transient over voltages with various protective schemes.

CO 4. Identify operation and control of microprocessor based relays.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1
Average	3	-	3	3	-	1

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22B	CORE 4: POWER SYSTEM OPERATION AND DEREGULATION	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power systems.

Module 1: Optimal Power Flow [9L]

Introduction - Solution to the optimal power flow - Gradient method - Newton's method - Linear sensitivity analysis - Linear programming methods - Security constrained OPF - Interior point algorithm - Bus incremental costs.

Module 2: Power System Security [9L]

Introduction – Factors affecting power system security-Contingency analysis - Detection of network problems - Linear sensitivity analysis - AC power flow methods - Contingency selection - Concentric relaxation - Bounding area method.

Module 3: State Estimation in Power Systems [9L]

Introduction - Power system state estimation - Maximum likelihood, Weighted least squares estimation - Matrix formulation - State estimation of AC network - State estimation by orthogonal decomposition - detection and identification of Bad measurements - Estimation of quantities not being measured - Network observability and pseudo measurements.

Module 4: Power System Deregulation [9L]

Introduction - motivation for restructuring of power systems - Electricity market entities model benefits of deregulation – Terminology - Deregulation in Indian power sector - Operations in power markets - Power pools - Transmission networks and electricity markets.

Module 5: Available Transfer Capability [9L]

Introduction methods of determination of ATC - ATC calculation considering the effect of contingency analysis - Transmission open access and pricing-Cost components of transmission system - Transmission pricing methods - Incremental cost based transmission pricing.

Text Books

1. Wood, A. J., Wollenberg, B. F., &Sheblé, G. B. 'Power Generation, operation and control', John Wiley &Sons, 2013.

2. T.K.Nagsarkar, M.S.Sukhija, 'Power system analysis', Oxford publications, 2007.

E-Resources

1) Https://www.sciencedirect.com/topics/engineering/real-time-applications-for-power systems.
2) https://digital-library.theiet.org/content/books/po/pbpo030e.
3) https://www.electrical4u.com/real-time-applications-for-power systems.
4) https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Understand the study of optimal power flows

CO 2. Discuss the power system security and challenges in secured operation of power system in real-time environment.

CO 3. Acquire knowledge of state estimation required for the real-time operation of power system.

CO 4. Understand the concept of Power System Deregulation.

CO 5. Analyze ATC and the cost of transmission.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.

4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22C	PROGRAM ELECTIVE – 3: HIGH VOLTAGE ENGINEERING	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power Systems and Electrical & Electronics Instrumentation.

Module 1: Introduction to high voltage engineering [9L]

Unit-I: [4L]

Electric field stresses, Gas / Vacuum as insulator, Liquid dielectrics, Solids and composites, Estimation and control of electric stress, Numerical methods for electric field computation**.**

Unit-II: [5L]

Surge voltages their distribution and control, Applications of insulating materials in transformers, Rotating machines, Circuit breakers, Cable power capacitors and bushings.

Module 2: Break down in dielectric materials [9L]

Unit-I: [4L]

Gases as insulating media, Collision process, Ionization process, Townsend's criteria of breakdown in gases**,** Paschen's law.

Unit-II: [5L]

Liquid as Insulator, pure and commercial liquids, Break down in pure and commercial liquids. Intrinsic breakdown, Electro mechanical breakdown, Thermal break down, Breakdown of solid dielectrics in practice, Breakdown in composite dielectrics, Solid dielectrics used in practice.

Module 3: Generation & measurement of high voltages & currents [9L]

Unit-I: [4L]

Generation of high direct current voltages, Generation of high alternating voltages, Generation of impulse voltages, Generation of impulse currents, Tripping and control of impulse generators

Unit-II: [5L]

Measurement of high DC voltages, Measurement of high voltages alternating and impulse, Measurement of direct alternating and impulse, Oscilloscope for impulse voltage and current measurements.

Module 4: Over voltages & insulation co-ordination [9L]

Unit-I: [4L]

Natural causes for over voltages: Lightning phenomenon, Overvoltage due to switching

surges, System faults and other abnormal conditions**.**

Unit-II: [5L]

Principles of insulation coordination on high voltage and extra high voltage power systems.

Module 5: Testing of materials & electrical apparatus [9L]

Unit-I: [5L]

Measurement of D.C Resistivity, Measurement of dielectric constant, loss factor and Partial discharge measurements.

Unit-II: [4L]

Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, testing of transformers, Testing of surge arresters and Radio interference measurements.

Text Books

1. M.S.Naidu and V. Kamaraju,"High Voltage Engineering" Tata McGraw HillPublications, Fifth Edition, 2013.
2. E.Kuffel, W.S.Zaengl, J.Kuffel, "High Voltage Engineering: Fundamentals", Elsevier, Second Edition, 2000.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ HIGH-VOLTAGE-ENGINEERING.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ HIGH VOLTAGE ENGINEERING.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Know conduction and breakdown will occur in gases, liquids and solids dielectrics, and different applications of the insulating materials in electrical power apparatus.

CO 2. Explain the insulation testing of various components in power systems for different types of voltages, namely power frequency A.C, high frequency, switching or lightning impulses, for which generation of high voltages in laboratories is essential.

CO 3. Interpret the necessity to measure the voltages and currents accurately, ensuring perfect safety to the personnel and equipment.

CO 4. Detect the necessary condition for all the electrical equipment which are capable of withstanding the over voltages which met in service like natural causes lightning or system originated ones switching or power frequency transient voltage.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1
Average	3	-	3	3	-	1

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

7.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22D	PROGRAM ELECTIVE 3: POWER QUALITY	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power Systems and Power Electronics.

Module 1: Introduction to Power Quality [9L]

Unit-I: [4L]

Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption**.**

Unit-II: [5L]

Overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring.

Module 2: Long & short interruptions [9L]

Unit-I: [4L]

Long interruptions – Definition – Difference between failures, outage, Interruptions – causes of Long interruptions – Origin of interruptions – Limits for the Interruption frequency – Limits for the interruption duration – Costs of Interruption – Overview of reliability evaluation to power quality, Comparison of observations and reliability evaluation.

Unit-II: [5L]

Short interruptions: Definition, Origin of short interruptions, Basic principle, Fuse saving, Voltage magnitude events due to re-closing, Voltage during the interruption, Monitoring of short interruptions, Difference between medium and low voltage systems. Multiple events, Single phase tripping – Voltage and current during fault period, Voltage and current at post fault period, Stochastic prediction of short interruptions.

Module 3: 1 & 3-Phase voltage sag characterization [9L]

Unit-I: [4L]

Voltage sag – Definition, Causes of voltage sag, Voltage sag magnitude, and monitoring, Theoretical calculation of voltage sag magnitude, Voltage sag calculation in non-radial systems, Meshed systems, and voltage sag duration.

Unit-II: [5L]

Three phase faults, Phase angle jumps, Magnitude and phase angle jumps for three phase unbalanced sags, Load influence on voltage sags.

Module 4: Power quality considerations in industrial power systems [9L]

Unit-I: [4L]

Voltage sag, Equipment behavior of power electronic loads, Induction motors, Synchronous motors, computers, Consumer electronics, Adjustable speed AC drives and its operation.

Unit-II: [5L]

Mitigation of AC Drives, Adjustable speed DC drives and its operation, Mitigation methods of DC drives.

Module 5: Mitigation of interruptions & voltage sags [9L]

Unit-I: [5L]

Overview of mitigation methods from fault to trip, reducing the number of faults, reducing the fault clearing time changing the power system, installing mitigation equipment, Improving equipment immunity, Different events and mitigation methods. System equipment interface – Voltage source converter, Series voltage controller, Shunt controller, combined shunt and series controller.

Unit-II: [4L]

PQ and EMC standards: Introduction to standardization, IEC electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

Text Books

1. Math H J Bollen, "Understanding Power Quality Problems" Wiley Publications, Volume 5, 2000.
2. C. Sankaran, "Power Quality", CRC Presss, First Edition, 2002.
3. Alexander Kusko, Marc Thompson, "Power Quality in Electrical Systems", Tata McGraw Hill Publishing Co. Ltd., New Delhi, First Edition, 2007.
4. Surajit Chattopadhyay, MadhuchhandaMitra, Samarjit Sengupta, "Electric Power Quality", Springer, First Edition, 2007.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ POWER QUALITY.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ POWER QUALITY.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Know the severity of power quality problems in distribution system.

CO 2. Understand the concept of voltage sag transformation from up-stream (higher voltages) to down-stream (lower voltage).

CO 3. Compute the concept of improving the power quality to sensitive load by various mitigating custom power devices.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22E	PROGRAM ELECTIVE – 3: HVDC TRANSMISSION	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power Systems and Power Electronics.

Module 1: Introduction to HVDC Transmission [4L]

Unit-I: [4L]

General consideration, Power handling capabilities of HVDC Lines, Basic Conversion principles and Static converter configuration.

Module 2: Static power converters [9L]

Unit-I: [4L]

3-pulse, 6-pulse, and 12-pulse converters, Converter station and Terminal equipment, Commutation process, Rectifier and inverter operation**,** Equivalent circuit for converter – Special features of converter transformers.

Unit-II: [5L]

Harmonics in HVDC Systems, Harmonic elimination, AC and DC filters.

Module 3: Control of HVDC converters and Systems [9L]

Unit-I: [4L]

Constant current, constant extinction angle and constant ignition angle control, Individual phase control and equidistant firing angle control DC power flow control.

Unit-II: [5L]

Interaction between HVAC and DC systems Voltage interaction, Harmonic instability problems and DC power modulation.

Module 4: MTDC systems& over voltages [9L]

Unit-I: [4L]

Series parallel and series parallel systems their operation and control.

Unit-II: [5L]

Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults.

Module 5: Converter faults & protection [5L]

Unit-I: [5L]

Converter faults, over current protection – Valve group, and DC line protection over voltage protection of converters, Surge arresters.

Text Books

1. E.W. Kimbark, "Direct Current Transmission", Wiley Inter Science, New York, Volume 1, 1971.
2. KR Padiyar, "High Voltage Direct current Transmission", New Age International Publishers, First Edition Reprint, 1992.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ HVDC TRANSMISSION.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ HVDC TRANSMISSION.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Compare the differences between HVDC and HVAC transmission.

CO 2. Analyze the rectifier and inverter commutating circuits.

CO 3. Identification of valve firing control schemes.

CO 4. Estimate the requirement of HVDC filters.

CO 5. Address the role of AC system faults on HVDC system.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the

specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.

4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22F	**PROGRAM ELECTIVE 4: VOLTAGE STABILITY**	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Computers Methods in Power Systems.

Module 1: Introduction to voltage stability [9L]

Unit-I: [4L]

Voltage stability, Voltage collapse, Voltage security, Physical relation indicating dependency of voltage on reactive power flow.

Unit-II: [5L]

Factors affecting voltage collapse and instability, previous cases of voltage collapse incidences.

Module 2: Graphical analysis of voltage stability [9L]

Unit-I: [4L]

Comparison of voltage and angular stability of the system; Graphical methods describing voltage collapse phenomenon

Unit-II: [5L]

P-V and Q-V curves, detailed description of voltage collapse phenomenon with the help of Q-V curves.

Module 3: Analysis of voltage stability [9L]

Unit-I: [4L]

Analysis of voltage stability on SMLB system: Analytical treatment and analysis.

Unit-II: [5L]

Voltage stability indices: Voltage collapse proximity indicator; Determinant of Jacobin as proximity indicators; Voltage stability margin.

Module 4: Power system loads [9L]

Unit-I: [4L]

Loads that influences voltage stability: Discharge lights, Induction Motor, Air-conditioning, heat pumps, electronic power supplies, OH lines and cables.

Unit-II: [5L]

Reactive power compensation: Generation and Absorption of reactive power; Series and Shunt compensation; Synchronous condensers, SVCs; OLTCs; Booster Transformers.

Module 5: Voltage stability margin [5L]

Unit-I: [5L]

Stability Margin: Compensated and un-compensated systems. Voltage Security: Definition; Voltage security; Methods to improve voltage stability and its practical aspects.

Text Books

1. T.V. Cutsem and C.Vournas, "Voltage Stability of Electric Power Systems", Kluwerpublishers, 1998.
2. P. Kundur, "Power System Stability and Control", Tata McGraw-Hill PublishingCompany Ltd., New Delhi, 1993.
3. Carson W. Taylor, "Power System Voltage Stability", McGraw-Hill Ryerson, Limited, 1994.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/VOLTAGE STABILITY.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/VOLTAGE STABILITY.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Summarize theoretical background of voltage stability.

CO 2. Illustrate voltage stability analysis using P-V and Q-V curves.

CO 3. Apply analytical methods for voltage stability analysis.

CO 4. Understand the basic concept and types of reactive power compensation.

CO 5. Compute voltage stability margin for voltage stability improvement.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22G	PROGRAM ELECTIVE 4: AI TECHNIQUES IN ELECTRICAL ENGINEERING	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Computers Methods in Power Systems.

Module 1: Artificial neural networks [9L]

Unit-I: [4L]

Introduction - Models of neural network - Architectures – Knowledge representation – Artificial intelligence and neural networks.

Unit-II: [5L]

Learning process – Error correction learning – Hebbian learning –Competitive learning – Boltzmann learning –Supervised learning – Unsupervised learning– Reinforcement learning.

Module 2: ANN Paradigms [4L]

Unit-I: [4L]

ANN Paradigms: Multi – layer perception using Back propagation algorithm, Self – organizing Map – Radial basis function network – Functional link, network – Hopfield network.

Module 3: Fuzzy logic [9L]

Unit-I: [4L]

Introduction – Fuzzy versus crisp – Fuzzy sets - Membership function – Basic fuzzy set operations – Properties of fuzzy sets – Fuzzy Cartesian product.

Unit-II: [5L]

Operations on fuzzy relations– Fuzzy logic – Fuzzy quantifiers-Fuzzy inference-Fuzzy rule based system-De fuzzification methods.

Module 4: Genetic Algorithms [9L]

Unit-I: [4L]

Introduction - Encoding – Fitness function-Reproduction operators - Genetic modelling – Genetic operators – Crossover- Single – Site crossover-Two point crossover –Multi point crossover-Uniform crossover – Matrix crossover - Crossover rate-Inversion &deletion.

Unit-II: [5L]

Mutation operator – Mutation – Mutation rate – Bit - wise operators-Generational cycle-convergence of genetic algorithm.

Module 5: Applications of AI techniques [9L]

Unit-I: [4L]

Load forecasting – Load flow studies – Economic load dispatch – Load frequency control – Single area system and two area system.

Unit-II: [5L]

Small signal stability (Dynamic stability), Reactive power control, Speed control of DC and AC Motors.

Text Books

1. S.Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms"- PHI, New Delhi, 2003.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/AI-TECHNIQUES-IN-ELECTRICAL ENGINEERING.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/facts-on-facts-theory-and-applications.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Define the advances in neural networks.

CO 2. Evaluate the design and control of fuzzy systems.

CO 3. Evaluate the design of various models in neural networks.

CO 4. Analyze the techniques of various types of neural networks.

CO 5. Design fuzzy logic system.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**3**	**1**
CO2	**3**	**-**	**3**	**3**	**3**	**1**
CO3	**3**	**-**	**3**	**3**	**3**	**1**
CO4	**3**	**-**	**3**	**3**	**3**	**1**
CO5	3	-	3	3	**3**	1
Average	**3**	**-**	**3**	**3**	**3**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22H	PROGRAM ELECTIVE 4: REACTIVE POWER COMPENSATION AND MANAGEMENT	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Reactive Power Compensation and Management.

Module 1: Load Compensation [4L]

Unit-I: [4L]

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.

Module 2: Steady state reactive power compensation in transmission system [9L]

Unit-I: [4L]

Uncompensated line – Types of compensation – Passive shunt and series and dynamic shunt compensation –Examples.

Unit-II: [5L]

Transient state reactive power compensation in transmission systems: Characteristic time periods – Passive shunt compensation – Static compensations- Series capacitor compensation –Compensation using synchronous condensers – Examples.

Module 3: Reactive Power Coordination [5L]

Unit-I: [5L]

Objective – Mathematical modelling – Operation planning – Transmission benefits – Basic concepts of quality of power supply – Disturbances- steady –State Variations – Effects of under voltages – Frequency –Harmonics, RF and electromagnetic interferences.

Module 4: Demand side management [9L]

Unit-I: [4L]

Load patterns – Basic methods load shaping – Power tariffs- KVAR based tariffs penalties for voltage flickers and harmonic voltage levels.

Unit-II: [5L]

Distribution side reactive power management: System losses –Loss reduction methods – Examples – Reactive power planning – Objectives –Economics Planning capacitor placement – Retrofitting of capacitor banks.

Module 5: User side reactive power management [9L]

Unit-I: [4L]

KVAR requirements for domestic appliances – Purpose of using capacitors – Selection of capacitors – Deciding factors – Types of available capacitor, characteristics and Limitations.

Unit-II: [5L]

Reactive power management in electric traction systems and are furnaces: Typical layout of traction systems – Reactive power control requirements – Distribution transformers- Electric arc furnaces – Basic operations- Furnaces transformer –Filter requirements – Remedial measures –Power factor of an arc furnace.

Text Books

1. T.J.E.Miller, "Reactive Power Control in Electric Power Systems", John Wiley and Sons, 1982.
2. D.M.Tagare, "Reactive Power Management", Tata McGraw Hill, F8irst Reprint, 2007.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/REACTIVE POWER COMPENSATION AND MANAGEMENT.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/REACTIVE POWER COMPENSATION AND MANAGEMENT.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Evaluate the design and control of different types of compensation.

CO 2. Articulate User side reactive power management.

CO 3. Articulate steady state and transient state reactive power compensation.

CO 4. Techniques for analyzing of reactive power management.

CO 5. Evaluate reactive power control requirements.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**3**	**1**
CO2	**3**	**-**	**3**	**3**	**3**	**1**
CO3	**3**	**-**	**3**	**3**	**3**	**1**
CO4	**3**	**-**	**3**	**3**	**3**	**1**
CO5	3	-	3	3	**3**	1
Average	**3**	**-**	**3**	**3**	**3**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak.

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

J.B INSTITUTE OF ENGINEERING & TECHNOLOGY (UGC Autonomous)			
M.Tech: SE	**L**	**T-P-D**	**C**
I Year - II Semester	**2**	**0-0-0**	**0**

PROFESSIONAL VALUE AND ETHICS
(Mandatory Course – II)

Course Objectives:

This course will enable students to:

1. Study the Professionalism, Communication and Professional Etiquettes.
2. Study the importance of Professional Values and Dedication.
3. Understand the Professional Ethics and Responsibilities
4. Study the Workplace Rights & Responsibilities.
5. Understand the Global Ethics and Values

UNIT-I: Profession & Professionalism

Definition of profession, Criteria of a profession - Definition and characteristics of professionalism, Concepts, attributes and indicators of professionalism, Challenges of professionalism: Personal identity vs Professional identity, Communication & Relationship with team members: Respectful and open communication and relationshippertainingtorelevantinterestsforethicaldecisionmaking, Professional Conduct: Following ethical principles, Adhering to policies, rules and regulation of the institutions, Professional etiquettes and behaviours, Professional grooming: Uniform, Dress code.

UNIT-II:ProfessionalValues

Values: Definition and characteristics of values, Value clarification, Personal and Professional values, Professional socialization: Integration of professional values with personal values, Importance of professional values, Compassion: Sympathy vs Empathy, Altruism, Dedication/Devotion to work, Respect for the Person-Human dignity, Privacy and confidentiality: Incidental disclosure, Honesty and integrity: Truth telling, Trust and credibility: Fidelity, Loyalty

UNIT-III: Professional Practices in Engineering:

Professions and Norms of Professional Conduct, Norms of Professional Conduct vs. Profession; Responsibilities, Obligations and Moral Values in Professional Ethics, Professional codes of ethics, the limits of predictability and responsibilities of the engineering profession.

Central Responsibilities of Engineers - The Centrality of Responsibilities of Professional Ethics; lessons from 1979 American Airlines DC-10 Crash and Kansas City Hyatt Regency Walk away Collapse.

UNIT-IV: Workplace Rights & Responsibilities

Ethics in changing domains of Research, Engineers and Managers; Organizational Complaint Procedure, difference of Professional Judgment within the Nuclear Regulatory Commission (NRC), the Hanford Nuclear Reservation.

UNIT-V: Impact of Global Development on Ethics and Values

Conflict of cross-cultural influences, mass media, cross-border education, materialistic values, professional challenges, and compromise. Defining the difference between aggressive, submissive, and assertive behaviours. Modern Challenges of Adolescent Emotions and behaviour; Sex and spirituality: Comparison and competition; positive and negative thoughts. Adolescent Emotions, arrogance, anger, sexual instability, selfishness, defiance.

TEXTBOOKS:

Text book on Professional ethics and human values by R.S.Nagarajan, New age international.

Professional ethics and human value by D.R.Kiran, Tata McGraw Hills education.

Ethics in engineering by Mike W. Martin and Roland Schinzinger, Tata McGraw Hills education.

Hurlock, E.B (2006). Personality Development, 28th Reprint. New Delhi: Tata McGraw Hill.

Stephen P. Robbins and Timothy A. Judge(2014), Organizational Behavior 16th Edition: Prentice Hall

REFERENCES:

Andrews, Sudhir. How to Succeed at Interviews. 21st (rep.) New Delhi, Tata McGraw-Hill 1988.

Heller, Robert. Effective leadership. Essential Manager series. Dk Publishing, 2002

Hindle, Tim. Reducing Stress. Essential Manager series. Dk Publishing, 2003

Lucas, Stephen. Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill. 2001

COURSE OUTCOMES:

On completion of the course, the students will be able to:

1. He / She will be good professional etiquettes.
2. Student will be a knowing professional values and dignity.
3. Student will be understanding professional ethics and responsibilities
4. Student will understand the Workplace Rights & Responsibilities.
5. He / She will understand the Global Ethics and Values

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22I	LABORATORY – 3: ELECTRICAL SIMULATION LAB-2	L	T	P	C
Credits: **2**		**0**	**0**	**4**	**2**

List of the Experiments:

1. Modelling of single area and multi-line Load frequency control in MATLAB SIMULINK.
2. Modelling AVR in MATLAB SIMULINK.
3. Modelling IEEE excitation systems in MATLAB SIMULINK.
4. Study of effect of Faults (LG, LL, LLG, 3 phase) on a single machine connected to infinite Bus.
5. Representation of Sequence Networks.
6. Modelling of Turbine and Governor System
7. Solution of Swing Equation by any one method.
8. Simulation of Single phase full converter using RL and E loads.
9. Simulation of Three phase full converter using RL and E loads.
10. Simulation of Single phase AC Voltage controller using RL load.
11. Simulation of Three phase inverter with PWM controller.

Course Outcomes

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

CO 1. Express economic operation of power system and importance of LFC control.

CO 2. Improve student's ability in solving problems related to Economic Load Dispatch, Load Frequency Control and reactive power control.

CO 3. Ability to discuss single area load frequency control and two area load frequency control.

CO 4. Ability to model and design turbine and automatic controller.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**3**	**3**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**2**	**2**
Average	**3**	**3**	**3**	**3**	**2**	**2**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22J	LABORATORY – 4: Power Systems Lab-2	L	T	P	C
Credits: **2**		**0**	**0**	**4**	**2**

List of the Experiments:

1. Determination of Equivalent circuit of a 3-Winding Transformer.
2. Determination of Sequence Impedances of Three Phase Transformer.
3. Characteristics of Over Current Electromagnetic Relay (7051 A).
4. Characteristics of Over Current Microprocessor based Relay (7051 B).
5. Characteristics of Over Voltage Electromagnetic Relay (7053 A).
6. Characteristics of Over Voltage Microprocessor based relay (7053 B).
7. Characteristics of Under Voltage and Negative Sequence Relays (i) UV Electromagnetic Relay (7052 A) (ii) Static Negative Sequence Relay (7055 B).
8. Characteristics of Under Voltage Microprocessor Based Relay (7052 B).
9. Performance and Testing of Feeder Protection System.
10. Performance and Testing of Transmission Line Model.

Course Outcomes

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

CO 1. Test and evaluate the performance of Power Transformers.

CO 2. Test and evaluate the performance of Transmission lines.

CO 3. Evaluate/Choose the various types of Relays (Electromagnetic, Static and Microprocessor based relays).

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**3**	**3**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**2**
Average	**3**	**3**	**3**	**3**	**2**	**2**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to

solve practical problems.

2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

J.B INSTITUTE OF ENGINEERING & TECHNOLOGY (UGC Autonomous)			
M.Tech:	**L**	**T-P-D**	**C**
I Year - II Semester	**2**	**0-0-0**	**2**
RESEARCH METHODOLOGY AND IPR **CORE: (Common to M.Tech - EPS, VLSISD, CAD-CAM, CSE & SE)**			

Course Objectives:

- To understand the basic concept of research problem formulation.
- To be exposed to effective research report writing and research design.
- To investigate the various methods of data collection and analysis.
- To understand the various fields of Industrial Property and PCT.
- To be exposed to administration of IP and new developments in IPR.

Course Outcomes:

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

1. Understand the basic concept of research problem formulation.
2. Develop an effective research proposal and research report.
3. Identify appropriate method for data collection and analysis for effective research.
4. Apply for Patent Filing and other fields of IP.
5. Make use of new developments in IPR.

UNIT-I:

Introduction

Meaning and Objectives of Research, Types of Research, Research Approaches, Research Methods Vs Methodology, Research Process, Criteria of Good Research.

Research Problem

Meaning of Research Problem, Steps involved in Selecting a Research Problem, Scope and Objectives of Research Problem, Sources of Research Problem, Characteristics of a Good Research Problem, Steps involved in Defining a Research Problem. Design thinking approach to formulate a research problem.

UNIT II

Effective technical writing

Importance of Literature Review, Steps involved in conducting a Literature Review, Research Report, Characteristics of a Good Report, Layout of a Research Report, Writing a Journal Paper, Writing a Research Proposal, Format of Research Proposal, Plagiarism and Research Ethics.

Research Design

Need for Research Design, Features of a Good Design, Important Concept Relating to Research Design, Design thinking principles,Categories of Research Design. Design thinking approach

UNIT-III

Data Collection

Methods of Primary Data Collection – Observation Method, Interview Method, Collection of Data through Questionnaire and Schedule, Collection of Secondary Data, Selection of Appropriate Method for Data Collection – Bibliometric Analysis.

Data Processing and Analysis

Processing Operations, Problems in Processing, Types of Analysis, Multivariate Analysis, Correlation Analysis, Regression Analysis.

UNIT-IV:

Fields of Intellectual Protection

Patents - Conditions of Patentability, Drafting and Filing a Patent Application, Examination of a Patent Application; Copyright - Copyright Protection, Subject Matter of Copyright Protection, Ownership of Copyright, Limitations on Copyright Protection; Trademarks - Definitions, Criteria of Protectability, Protection of Trademark Rights; Industrial Designs; Geographical Indications.

International cooperation on intellectual property

World Intellectual Property Organization (WIPO) - Patenting under PCT; Patent information and databases; Licensing and transfer of technology.

Unit V

Administration of Industrial Property

Administrative Structure in the Industrial Property Office, Patent Office, Trademark Office, Industrial Designs Office, Patent and Trademark Attorney.

New Developments in IPR

Technological and Legal Developments in Intellectual Property, Traditional Knowledge, Case Studies.

TEXT BOOKS:

1. Stuart Melville and Wayne Goddard, "Research Methodology: An Introduction for Science & Engineering Students'', Juta& Co. Ltd Publishers, Revised Second Edition, 2006.
2. Halbert, "Resisting Intellectual Property", Routledge, Taylor & Francis Ltd, First Edition, 2007.
3. C. R. Kothari, "Research Methodology: Methods and Techniques", New Age International Publications, Revised Second Edition, 2004.

REFERENCE BOOKS:

1. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners", British Library Publishers, Fourth Edition, 2014.

2. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age",Wolters Kluwer Law & Business Publishers, 2016.
3. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand Publications, First Edition, 2008

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS II Year-I Sem			
Course Code: LM23A	PROGRAM ELECTIVE 5: ELECTRIC VEHICLES AND POWER MANAGEMENT	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power Systems.

Module 1: ELECTRIC VEHICLES AND VEHICLE MECHANICS [9L]

Unit-I: [9L]

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings, Comparisons of EV With internal combustion Engine vehicles, Fundamentals of vehicle mechanics.

Module 2: ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS [9L]

Unit-I: [9L]

Architecture of EV's and HEV's – Plug-n Hybrid Electric Vehicles (PHEV) - Power train Components and sizing, Gears, Clutches, Transmission and Brakes.

Module 3: CONTROL OF DC AND AC DRIVES [9L]

Unit-I: [4L]

DC/DC chopper based four quadrant operations of DC drives – Inverter based V/f Operation (Motoring and braking) of induction motor drive system**.**

Unit-II: [5L]

Induction motor and permanent motor based vector control operation – Switched reluctance motor (SRM) drives.

Module 4: BATTERY ENERGY STORAGE SYSTEM [9L]

Unit-I: [9L]

Battery Basics, Different types, Battery Parameters, Battery modelling, Traction Batteries.

Module 5: ALTERNATIVE ENERGY STORAGE SYSTEMS [9L]

Unit-I: [9L]

Fuel cell – Characteristics- Types – hydrogen Storage Systems and Fuel cell EV – Ultra Capacitors.

Text Books

1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second

Edition" CRC Press, Taylor & Francis Group, Second Edition (2011).
2. 2 Ali Emadi, MehrdadEhsani, John M.Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel dekker, Inc 2010.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ELECTRIC-VEHICLES-AND-POWER-MANAGEMENT.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ ELECTRIC-VEHICLES-AND-POWER-MANAGEMENT.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Understand the operation of Electric vehicles and various energy storage technologies for electrical vehicles.

CO 2. Knowledge on architecture of EV's and power train components.

CO 3. Knowledge on control of dc and ac drives.

CO 4. Understanding the battery energy storage system.

CO 5. Knowledge on alternative energy storage systems.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the

performance of Power systems& Drives.

5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS II Year-I Sem			
Course Code: LM23B	PROGRAM ELECTIVE 5: MODERN CONTROL THEORY	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Control Systems

Module 1: State variable analysis [9L]

Unit-I: [4L]

The concept of state – State equations for dynamic systems– Time invariance and linearity – Non-uniqueness of state model – State diagrams for continuous - Time state models.

Unit-II: [5L]

Linear continuous time models for physical systems – Existence and uniqueness of solutions to continuous - Time state equations – Solutions of linear time invariant continuous - Time state equations – State transition matrix and its properties.

Module 2: State variable analysis & design [9L]

Unit-I: [4L]

General concept of controllability – General concept of observability – Controllability tests for continuous -Time invariant systems – Observability tests for continuous**.**

Unit-II: [5L]

Time invariant systems – Controllability and observability of state model in Jordan Canonical form – Controllability and observability canonical forms of state model.

Module 3: Non - linear systems [9L]

Unit-I: [5L]

Introduction – Non-linear systems - Types of non-linearity's – Saturation – Dead-Zone - Backlash – Jump phenomenon etc.; – Singular points.

Unit-II: [4L]

Introduction to linearization of non - linear systems, Properties of non-linear systems, Describing function, Describing function analysis of non-linear systems, Stability analysis of non-linear systems through describing functions.

Module 4: Phase plane methods [9L]

Unit-I: [9L]

Introduction to phase-plane analysis, Method of isoclines for constructing trajectories, Singular points, Phase-plane analysis of non-linear control systems.

Module 5: Stability analysis [9L]

Unit-I: [4L]

Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems - Stability analysis of the linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

Unit-II: [5L]

State feedback controller design through pole assignment – State observers: Full order and reduced order.

Text Books

1. M.Gopal, "Modern Control System Theory", New Age International, Revised Second Edition, 1993.
2. OgataKatsuhiko, "Modern Control Engineering", Pearson Education Publication, Fifth Edition, 2010.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/MODERN CONTROL THEORY.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/MODERN CONTROL THEORY.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Apply the knowledge of basic and modern control system for the real time analysis.

CO 2. Design the real time control systems.

CO 3. Understand the concepts of state variables analysis.

CO 4. Analyse the concept of stability of nonlinear systems.

CO 5. Get the knowledge on phase plane methods.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1

CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS II Year-I Sem			
Course Code: LM23C	**PROGRAM ELECTIVE 5: DISTRIBUTED GENERATION AND MICRO GRID**	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Control Systems

Module 1: Need for Distributed Generation [9L]

Unit-I: [9L]

Renewable sources in distributed generation - Current scenario in distributed generation - Planning of DGs – Siting and sizing of DGs – Optimal placement of DG sources in distribution systems.

Module 2: Grid Integration of DGs [9L]

Unit-I: [4L]

Different types of interfaces - Inverter based DGs and rotating machine based interfaces - Aggregation of multiple DG units.

Unit-II: [5L]

Energy storage elements - Batteries, ultra capacitors, flywheels.

Module 3: Technical Impacts of DGs [9L]

Unit-I: [9L]

Transmission systems, Distribution systems, De-regulation – Impact of DGs upon protective relaying – Impact of DGs upon transient and dynamic stability of existing distribution systems.

Module 4: Economic and Control Aspects of DGs [9L]

Unit-I: [9L]

Market facts, issues and challenges - Limitations of DGs - Voltage control techniques, Reactive power control, Harmonics, Power quality issues - Reliability of DG based systems – Steady state and Dynamic analysis.

Module 5: Introduction to Micro-grids [9L]

Unit-I: [4L]

Types of micro-grids – Autonomous and non-autonomous grids – Sizing of micro-grids - Modeling & analysis - Micro-grids with multiple DGs.

Unit-II: [5L]

Micro-grids with power electronic interfacing units - Transients in micro-grids - Protection of micro-grids – Case studies.

Text Books

1. H. Lee Willis, Walter G. Scott, 'Distributed Power Generation – Planning and Evaluation', Marcel Decker Press, 2000.
2. M.GodoySimoes, Felix A.Farret, 'Renewable Energy Systems – Design and Analysis with Induction Generators', CRC press.
3.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/DISTRIBUTED-GENERATION-AND-MICRO GRID.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/DISTRIBUTED GENERATION AND MICRO GRID.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Find the size and optimal placement DG

CO 2. Analyze the impact of grid integration and control aspects of DGs

CO 3. Model and analyze a micro grid taking into consideration the planning and Operational issues of the DGs to be connected in the system

CO 4. Describe the technical impacts of DGs in power systems.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1
Average	3	-	3	3	-	1

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to

solve practical problems.

2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS II Year-I Sem			
Course Code: LM2OA	**OPEN ELECTIVE - RENEWABLE ENERGY TECHNOLOGIES AND BATTERY STORAGE SYSTEMS**	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Renewable Energy Sources.

Module 1: Fundamentals of Energy [9L]

Unit-I: [4L]

Energy consumption and standard of living, Oil crisis, Classification of energy resources, Consumption trend of primary energy resources, conventional energy sources and their distribution, Energy chain, common forms of energy.

Unit-II: [5L]

Importance and salient features of nonconventional energy resources, environmental aspects of energy, Environment-economy-energy and sustainable development, Energy densities of various fuels, World energy status, Energy scenario in India.

Module 2: Solar energy [9L]

Unit-I: [4L]

Solar energy basics, Sun - Earth relation spectrum, Terrestrial and extra- terrestrial radiation, spectral energy distribution of solar radiation and Depletion of solar radiation**.**

Unit-II: [5L]

measurement of solar radiation, solar radiation data, Solar time, Solar radiation geometry, Solar day length, Empirical equations for estimation of solar radiation on horizontal surfaces, Global, diffused and beam radiation, Solar radiation on inclined surface (Problems on energy availability on surfaces).

Module 3: Wind Energy [9L]

Unit-I: [4L]

Wind origin, nature, types, Wind data and wind rose, wind speed variation, Wind siting Wind turbine classification and types of rotors, Wind turbine aerodynamics, power extraction from wind, Betz criteria, Axial thrust on the turbine.

Unit-II: [5L]

torque developed by the turbine, Dynamic matching, speed control strategies, Wind turbine operational characteristics, wind energy conversion systems, environmental aspect, Wind energy potential and installation in India (Problems on energy Conversion).

Module 4: Biomass Energy [9L]

Unit-I: [4L]

Biomass resources and their classification**,** Biomass conversion technologies: Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion – operational parameters of biogas plants.

Unit-II: [5L]

Types of biogas Plants and biogas plant design – Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy program in India (Problems on biogas plant design)

Module 5: Electrical Energy Storage Technologies [9L]

Unit-I: [9L]

Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, Long distance between generation and consumption, Congestion in power grids, Transmission by cable.

Text Books

1. Renewable Energy Sources, Twidell, J.W. and Weir, A., EFN Spon Ltd., 1986.
2. Renewable Energy Engineering and Technology, Kishore VVN, Teri Press, New Delhi, 2012
3. "James M. Eyer, Joseph J. Iannucci and Garth P. Corey ", "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/Fundamentals of Energy.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/Fundamentals of Energy.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. An understanding of renewable energy sources.

CO 2. Knowledge of working principle of various energy systems.

CO 3. A capability to carry out basic design of certain renewable energy systems.

CO 4. Analyze the characteristics of energy from various sources and need for storage.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1
Average	3	-	3	3	-	1

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS II Year-I Sem			
Course Code: LM2OB	**OPEN ELECTIVE – SOLAR AND ENERGY STORAGE SYSTEMS**	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power systems and renewable energy sources.

Module 1: Introduction [9L]

Characteristics of sunlight – semiconductors and P-N junctions –behavior of solar cells – cell Properties – PV cell interconnection.

Module 2: Stand Alone PV System [9L]

Solar modules – storage systems – power conditioning and regulation - MPPT- protection – stand-alone PV systems design – sizing.

Module 3: Grid Connected PV Systems [9L]

PV systems in buildings – design issues for central power stations – safety – Economic Aspect – Efficiency and performance - International PV programs.

Module 4: Energy Storage Systems [9L]

Impact of intermittent generation – Battery energy storage – solar thermal energy storage – pumped hydroelectric energy storage.

Module 5: Applications [9L]

Water pumping – battery chargers – solar car – direct-drive applications – Space – Tele communications.

Text Books

1. Solanki C.S., "Solar Photovoltaics: Fundamentals, Technologies And Applications", PHI Learning Pvt. Ltd.,2015.
2. Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, "Applied Photovoltaics", 2007,Earthscan, UK. Eduardo Lorenzo G. Araujo, "Solar electricity engineering of photovoltaic systems", Progensa,1994.
3. Frank S. Barnes & Jonah G. Levine, "Large Energy storage Systems Handbook", CRC Press, 2011.
4. McNeils, Frenkel, Desai, "Solar & Wind Energy Technologies", Wiley Eastern, 1990.

5. S.P. Sukhatme , "Solar Energy", Tata McGraw Hill,1987.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/SOLAR-AND-ENERGY-STORAGE SYSTEMS.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/SOLAR AND ENERGY STORAGE SYSTEMS.
4. https://nptel.ac.in/courses.

Course Outcomes

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

CO 1. Develop more understanding on solar energy storage systems

CO 2. Develop basic knowledge on standalone PV system

CO 3. Understand the issues in grid connected PV systems

CO 4. Study about the modelling of different energy storage systems and their performances

CO 5. Attain more on different applications of solar energy

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.