Learning Outcomes based Curriculum Framework (LOCF)

For

Master of Technology
(Electrical Engineering)
Two Year Regular Full-Time
Postgraduate Programme

Faculty of Engineering and Technology
Chaudhary Devi Lal University
Sirsa-125055
2022

Contents

1. About the Faculty of Engineering & Technology

The Faculty covers the professional and academic programmes/courses run in the university teaching department of computer science and engineering, university school of graduate studies, affiliated general degree colleges, institute of computer applications and engineering colleges. BTech and MTech programmes in major disciplines and MCA, MSc Data Science, BSc Data Science, BCA programmes are managed by the Faculty.

2. Learning Outcome based Curriculum Framework

The CBCS evolved into learning outcome based curriculum framework and provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates.

2.1 Objectives of the programme

After spending two years in their profession Master of Technology (Electrical Engineering) Regular Full-Time graduates are expected to:

- apply knowledge and expertise - gained thus far - in problem-solving skills development and maintenance of infrastructure construction, tools, applications; academia and research in local and cross-border settings;
- be well adept in management of infrastructure development projects bearing techno-economical and social-behavioural delimitations; management of educational and research establishment; management of own start-up enterprise.
- exhibit support for peers and leadership by spearheading the projects teams; entrepreneurial skills by conceptualising new projects management technique; contributing to research and academia by way of undertaking research and academic assignments.
- engage in lifelong learning, career enhancement and adapt to changing professional, societal, and environmental needs in a way conforming to his/her position in the profession/vocation;
- develop communication skills necessary to function productively in the given settings to achieve a successful professional/vocational career with academic and professional ethics and social obligations.

2.2 Programme Outcomes (POs)

PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

2.3 Programme Specific Outcomes (PSOs)

The graduates of the Master of Technology (Electrical Engineering) programme will have/be:

PSO1	ample knowledge of principles and practices of electrical engineering and capability of putting these principles to use in solving relevant problems.
PSO2	working knowledge of using modern computing tools and technologies like simulation & modelling, MATLAB, PSIM and ETAP tools in development and operations of various flavours of power system applications and in conduct of computing research.
PSO3	well acquainted in adoption and application of skills gained during research and practice and exhibit a taste for adopting trending software processes to solve computing problems.
PSO4	working knowledge set for practicing their respective vocation/profession with ethics, integrity, leadership, and social responsibility.
PSO5	equipped to achieve their career goals in the academia/industry or pursue higher studies and enhance their professional knowledge.

3. Programme Structure

Master of Technology (Electrical Engineering) is a four-semester postgraduate programme of 76 credits weightage consisting of Core Courses (CC), Discipline Specific Elective Courses (DSC), Skill Enhancement Courses (SEC) and Open Elective Courses (OEC).

Table 1: Master of Technology (Electrical Engineering) Credit Scheme

Sem	Core Courses (CC)		Discipline Specific Elective Courses (DSC)		Skill Enhancement Courses (SEC)		Open Elective Courses(OEC)*		Total Credit
	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	
I	05	16	02	08	-	-	-	-	24
II	04	12	02	08	-	-	01	04	24
III	01	04	-	-	01	04	01	04	12
IV	-	-	-	-	01	16	-	-	16
Total	10	32	04	16	02	20	02	08	76
%age	-	42.10	-	21.05	-	26.31	-	10.52	100

*A total of 08 credits are to be earned from other Engineering Departments or from MOOCs.

Table 2: Detailed break-up of Courses' Type (Semester wise)

Semester	Core Courses	Discipline Specific Elective Courses	Skill Enhancement Courses	Open Elective Courses	Total Courses
I	CC1 CC2 CC3 CC4 CC5	DSC1 DSC2	-		7
II	CC6 CC7 CC8 CC9	DSC3 DSC4	-	OEC1	7
III	CC10	-	SEC1	OEC2	3
IV	-	-	SEC2	-	1

Table 3(a): Master of Technology (Electrical Engineering) Course codes, Titles and Credits

SEMESTER - I								
#	Course Code	Course Title	L	P	Total	Int.	Ext.	Cr.
1	MTech/EE/1/CC1	Advanced Power SystemAnalysis	4	-	4	30	70	4
2	MTech/EE/1/CC2	Advanced Instrumentation &Control	4	-	4	30	70	4
3	MTech/EE/1/DSC1	Discipline Specific Elective Course – 1	4	-	4	30	70	4
4	MTech/EE/1/DSC2	Discipline Specific Elective Course - 2	4	-	4	30	70	4
5	MTech/EE/1/CC3	Research Methodology and IPR	4	-	4	30	70	4
6	MTech/EE/1/CC5	Advanced Power System Lab-I	-	2	2	30	70	2
7	MTech/EE/1/CC4	Instrumentation & Control Lab	-	2	2	30	70	2
		Total	**20**	**4**	**24**	**210**	**490**	**24**
SEMESTER – II								
#	Course Code	Course Title	L	P	Total	Int.	Ext.	Cr.
1	MTech/EE/2/CC6	Advanced Power System Protection	4	-	4	30	70	4
2	MTech/EE/2/CC7	Intelligent Control	4	-	4	30	70	4
3	MTech/EE/2/DSC3	Discipline Specific Elective Course - 3	4	-	4	30	70	4

4	MTech/EE/2/DSC4	Discipline Specific Elective Course - 4	4	-	4	30	70	4
5	MTech/EE/2/OEC1	Open Elective Course - 1	4	-	4	30	70	4
6	MTech/EE/2/CC8	Modeling & Simulation Lab	-	2	2	30	70	2
7	MTech/EE/2/CC9	Advanced Power System Lab-II	-	2	2	30	70	2
		Total	20	**4**	**24**	**210**	**490**	**24**
SEMESTER – III								
#	**Course Code**	**Course Title**	**L**	**P**	Total	Int.	Ext.	Cr.
1	MTech/EE/3/CC10	Advanced Electric Drives	4	0	4	30	70	4
2	MTech/EE/3/SEC1	Dissertation Part - 1	-	4	4	100	--	4
3	MTech/EE/3/OEC2	Open Elective Course - 2	4	0	4	30	70	4
Total			**8**	**4**	**12**	**160**	**140**	**12**
SEMESTER – IV								
#	**Course Code**	**Course Title**	**L**	**P**	Total	Int.	Ext.	Cr.
1	MTech/EE/4/SEC2	Dissertation Part - 2	-	16	16	-	400	16
						Total	**100**	**16**
							Grand Total Credit	**76**

Table 3(b): List of Discipline Specific Elective Courses with codes and titles

Discipline Specific Elective Courses-1		
1.	MTech/EE/1/DSC1(i)	Renewable Energy Resources
2.	MTech/EE/1/DSC1(ii)	Power Electronics Applications in Renewable Energy
3.	MTech/EE/1/DSC1(iii)	Smart Grid
Discipline Specific Elective Courses-2		
1.	MTech/EE/1/DSC2(i)	Bio-Medical Signal & Image Processing
2.	MTech/EE/1/DSC2(ii)	Advanced Digital Signal Processing
3.	MTech/EE/1/DSC2(iii)	Bio-Medical Instrumentation
Discipline Specific Elective Courses-3		
1.	MTech/EE/2/DSC3(i)	HVDC Transmission & FACTS Devices
2.	MTech/EE/2/DSC3(ii)	Transients in Power System
3.	MTech/EE/2/DSC3(iii)	Advanced Power Distribution & Automation
Discipline Specific Elective Courses - 4		
1.	MTech/EE/2/DSC4(i)	Digital Control System
2.	MTech/EE/2/DSC4(ii)	Advanced Microprocessors
3.	MTech/EE/2/DSC4(iii)	Reliability Engineering

Table 4: Master of Technology (Electrical Engineering) Courses' List

Course Code	Course Title	Credits
Core Courses		
MTech/EE/1/CC1	Advanced Power Systems Analysis	04
MTech/EE/1/CC2	Advanced Instrumentation & Control	04
MTech/EE/1/CC3	Research Methodology & IPR	04
MTech/EE/ 1/CC4	Instrumentation & Control Lab	02
MTech/EE/1/CC5	Advanced Power Systems Lab-1	02
MTech/EE/2/CC6	Advance Power System protection	04
MTech/EE/2/CC7	Intelligent Control	04
MTech/EE/2/CC8	Modelling & Simulation Lab	02

MTech/EE/2/CC9	Advanced Power System Lab- II	02
MTech/EE/3/CC10	Advanced Electric Drives and Control	04
Discipline Specific Elective Courses		
MTech/EE/1/DSC1(i)	Renewable Energy Resources	04
MTech/EE/1/DSC1(ii)	Power Electronics Application in Renewable Energy	
MTech/EE/1/DSC1(iii)	Smart Grid	
MTech/EE/1/DSC2(i)	Bio-medical signal & Image Processing	04
MTech/EE/1/DSC2(ii)	Advanced Digital Signal Processing	
MTech/EE/1/DSC2(iii)	Bio-Medical Instrumentation	
MTech/EE/2/DSC3(i)	HVDC Transmission & FACTS Devices	04
MTech/EE/2/DSC3(ii)	Transients in Power System	
MTech/EE/2/DSC3(iii)	Distribution & Automation	
MTech/EE/2/DSC4(i)	Digital Control System	04
MTech/EE/2/DSC4(ii)	Advanced Microprocessor	
MTech/EE/2/DSC4(iii)	Reliability Engineering	
Skill Enhancement Courses		
MTech/EE/3/SEC1	Dissertation Part-1	04
MTech/EE/4/SEC2	Dissertation Part-2	16
Open Elective Courses		
MTech/EE/1/OEC1	Students shall complete a 4-credit open elective course offered by other Engineering Departments/MOOCs	04
MTech/EE/2/OEC2	Students shall complete a 4-credit open elective course offered by other Engineering Departments/MOOCs	04
Open Electives Courses offered to the students of other Departments		
EE/OEC1	Non-Conventional Energy Resources	04
EE/OEC2	Solar Energy Engineering	04
EE/OEC3	Energy Management and Auditing	04
EE/OEC4	Energy Efficient Buildings	04

Note: 1. Each admitted student is required to submit the report of his/her Dissertation Part-I as per the schedule mentioned in Academic calendar for the corresponding academic session otherwise the Dissertation Part-II cannotbe continued at any level.

Note: 2. Each admitted student is required to submit his/her final Dissertation Part-II as per the schedule mentioned in Academic calendar for the corresponding academic session only after the publication of one Research paper in a journal/International/National conference of repute like IEEE, Springer, and Elsevier etc.

MTech/EE/1/CC1 Advanced Power System Analysis							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	To enable students to analyse power system networks, various faults, load flow study, security and contingency analysis.
Course Outcomes: After completion of course students will be able to	
CO1	Understand matrices related to power system and its formation with different methods.
CO2	Understand how to analyze various types of faults in power system
CO3	Study various methods of load flow and their advantages and disadvantages
CO4	Understand need of power system security, state estimation and contingency analysis

UNIT1

Network Modelling: System graph, loop, cut set and Incidence matrices, Primitive network and matrix, Formation of various network matrices by singular transformation.

Bus Impedance Algorithm: Singular transformation, direct inspection, Building Block algorithm for bus impedancematrix, Addition of links, addition of branches, (considering mutual coupling).

UNIT2

Balanced and unbalanced network elements: Representation of three phase network elements, representation under balanced and unbalanced excitation, transformation matrices, symmetrical components, sequence impedances, unbalanced elements and three phase power invariance.

Short circuit studies: Network representations for single line to ground fault, line to line fault, LL-G fault, and 3-phase faults, Short circuit calculations for various types of faults in matrix form.

UNIT3

Load flow studies: Load flow and its importance. Classification of buses, load flow techniques, Iterative solutions and computer flow charts using Gauss-Seidel and Newton-Raphson methods, Decoupled and fast decoupled methods, Representation of regulating and off nominal ratio transformers and modification of Y_{bus}.

UNIT4

Power system security: Introduction to Power system security, Addition and removal of multiple lines, network reduction for contingency analysis, current injection, shift destitution factor, single outage contingency analysis.

State estimation in power systems: data acquisition system, Method of least-squares, State estimation by weighted least square technique.

Suggested Books:

1. Stagg G W, EI-Abaid A H, "Computer methods in Power system analysis", McGraw Hill.
2. Singh L P, "Advanced Power System Analysis and Dynamics", New Age, Int. Publication.
3. Ramana N V, "Power System Analysis", Pearson Education.
4. Nagsarkar T K, Sukhija M S, "Power System Analysis", Oxford University Press.
5. Uma Rao K, "Computer Techniques and Models in Power System", IK Publications.
6. Grainger J J, Stevenson W D, "Power System Analysis", McGraw Hill.
7. Allen Wood, Bruce Wollenberg, "Power Generation operation & control", John Wiley & Sons.
8. Nagrath I J, Kothari D P, "Power System Engineering" McGraw Hill, New York.
9. Pai M A, "Computer Techniques in Power System Analysis", 2nd Edition, TMH-New Delhi.

CO-PO Mapping Matrix for Course MTech/EE/1/CC1												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	2	-	1	-	-	-	1	1
CO2	1	2	1	-	-	-	2	1	2	1	-	-

CO3	2	3	-	1	-	-	-	1	1	2	-	-
CO4	1	2	1	-	3	-	-	-	2	1	-	-

Correlation level: 1- Slight /Low **2-**Moderate/ Medium **3**- Substantial/High

MTech/EE/1/CC2 Advanced Instrumentation & Control							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	This course will look at different types of Instruments with their controls.
Course Outcomes: After completion of course students will be able to	
CO1	Understand different types of **Instruments** with their applications.
CO2	Understand basics of smart Sensor with their advantages ,disadvantages and applications
CO3	To emphasize and analysis of Virtual Instruments.
CO4	To study different types of VI structures

Unit 1

Transducers: Introduction, Characteristics and Classifications of electrical transducers, measurement of displacement, Force, pressure, speed, temperature and intensity of light using different electrical transducers, advantages, disadvantages and applications of transducers

. **Unit 2**

Smart Sensors: Introduction, architecture of smart sensor, optical sensor, microelectronic sensor, chemical, Bio Sensor and Physical Sensor, piezo-resistive pressure sensor, fibre optic temperature sensor, light sensor, advantages, disadvantages and applications of smart sensors.

Unit 3

Virtual Instrumentation: Introduction, architecture of VI, Evaluation and architecture of VI, conventional Virtual Instrumentation, Advantage of Lab View, Software Environment, Creating and Saving VI, front Panel and block diagram Tool Bar, Palettes, front panel control and indicators, block diagram: Terminals, Nodes, Functions, Sub VI, Data Flow Program.

Unit 4

VI Structures: Control structures, selection structures, case structures, Sequence structures, formula node, array, single and multi-dimensional array, auto indexing, clusters, creating clusters control and indicators, data plotting.

Suggested Books:

1. Johnson G W, "Lab VIEW Graphical Programming", Second edition, McGraw Hill.
2. Kring J & Travis J, "LabVIEW for everyone", Prentice Hall, New Jersey.
3. James K, "PC Interfacing and Data Acquisition", Elsevier.
4. Jerome J, "Virtual Instrumentation using Lab View", Prentice Hall, India.

CO-PO Mapping Matrix for Course MTech/EE/1/CC2												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	3	2	2	-	1	-	1	-	1	1
CO2	1	1	1	-	-	-	1	1	-	1	-	-
CO3	2	3	-	1	-	-	-	1	1	2	-	-

CO4	1	2	3	-	1	-	-	-	2	1	-	-

MTech/EE/1/DSC1**(i): Renewable Energy Resources**							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the knowledge of renewable energy resources and different factors related to them.
Course Outcomes: After completion of course students will be able to	
CO1	To impart knowledge about renewable energy resources and solar power system.
CO2	To acquaint students with the phenomenon of wind power system and its applications with grid.
CO3	To impart knowledge to students about geothermal and ocean power system.
CO4	To let student understand fuel cell, hydrogen and hybrid energy system.

Unit 1

ENERGY RESOURCES: Renewable energy sources, distributed energy systems and dispersed generation, atmospheric aspects of electric energy generation, Impact of renewable energy generation on environment

SOLAR ENERGY: Solar Radiation and its Measurement, Solar Thermal Energy Collectors: different types of collectors and their performance analysis, Solar Thermal Energy Conversion System: solar water heater, solar distillation, slat thermal power plant and various applications of solar system, Solar Photovoltaic System: solar cell, VI characteristics, solar electricity and grid and off-grid solar system.

Unit 2

WIND ENERGY: Wind turbines and rotors, Wind Energy Extraction, Wind Characteristics, Power Density DurationCurve, Design of Wind Turbine Rotor, Design of Regulating System for Rotor, Wind Power Generation Curve, Sub- systems of a Horizontal Axis Wind Turbine Generator, Modes of Wind Power Generation, Estimation of Wind Energy Potential, Selection of Optimum Wind Energy Generator (WEG), Grid Interfacing of a Wind Farm, Methods of GridConnection, Grid System and Properties, Capacity of Wind Farms for Penetration into Grid, Control System for Wind Farms, Economics of Wind Farms

Unit 3

GEOTHERMAL ENERGY: Structure of the Earth's Interior, Plate Tectonic Major Test, Geothermal Sites, Geothermal Field, Geothermal Gradients, Geothermal Resources, Geothermal Power Generation, Geothermal Electric Power Plant, Geothermal-Preheat Hybrid with Conventional Plant

OCEAN ENERGY: Development of a Tidal Power Scheme, Grid Interfacing of Tidal Power, Wave Energy, Mathematical Analysis of Wave Energy, Empirical Formulae on Wave Energy, Wave Energy Conversion, Principle of Wave Energy plant, Wave Energy Conversion Machines.

Unit 4

FUEL CELLS: Principle of Operation of Fuel Cell, Fuel Processor, Fuel Cell Types, Energy Output of a Fuel Cell,Efficiency, and EMF of a Fuel Cell, Operating Characteristics of Fuel Cells, Thermal Efficiency of Fuel Cell

HYDROGEN ENERGY SYSTEM: Hydrogen Production, Hydrogen Storage, Development of Hydrogen Cartridge,Gas Hydrate

HYBRID ENERGY SYSTEMS: Hybrid Systems AND ITS Types, Electric and Hybrid Electric Vehicles, Hydrogen-Powered-Electric Vehicles.

Suggested Books:

1. Kothari DP, Singal KC, Ranjan Rakesh, "Renewable energy sources and emerging technologies, 2nd ed, Prentice

Hall (India)
2. Rai G D, “Non-Conventional Sources of Energy, Khanna Publishers.
3. Bansal N K, Kleemann M, Heliss M, “Renewable energy sources and conversion technology”, McGraw HillEducation.
4. Abbasi S A, Abbasi N, “Renewable energy sources and their environmental impact”, PHI.
5. Mittal KM, “Renewable energy Systems”, Wheelar Publishing.
6. Mukherjee D, “Renewable energy Systems”, New Age International.

CO-PO Mapping Matrix for Course MTech/EE/1/DSC1**(i)**												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	-	-	-	1	-	-	-	1	1
CO2	1	2	1	-	-	-	2	1	-	1	-	-
CO3	1	1	-	1	-	-	-	1	1	2	-	-
CO4	1	2	1	-	2	-	-	-	-	1	-	-

MTech/EE/1/DSC1**(ii): Power Electronics Applications in Renewable Energy**							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the application of power system in renewable energy resources.
Course Outcomes: After completion of course students will be able to	
CO1	To impart knowledge about power electronics devices and DC-DC converters.
CO2	To acquaint students with the modern power electronics converters.
CO3	To impart knowledge to students about power electronics interface devices for solar energy.
CO4	To let student understand wind energy interfacing devices.

Unit1

Review of Power Devices: SCR, BJT, MOSFET, IGBT, GTO, Safe operating Limits, Selection of devices for various applications.

Phase controlled Converters: **(**1-ϕ&3-ϕ) thyristor fed half controlled, fully controlled and Dual converters with inductive and motor load.

DC to DC converters: Analysis of various conduction modes of Buck, Boost, Buck-Boost.

Unit2

Modern Power Electronic Converters: Basic concepts of VSI, single phase half bridge, full bridge and three phase bridge inverters, PWM modulation strategies, Sinusoidal PWM, Space vector modulation, Selective Harmonic Elimination method, other inverter switching schemes, blanking time, Current source inverters.

Unit3

Design of Power Electronics Interfaces for Solar PV: Solar PV technologies, MPPT, Design of DC-DC converters for MPPT, MPPT algorithms, Implementation of MPPT control through DSP controllers. Topologies for grid connectedand standalone applications: single phase and three phase systems, Single stage and multistage, isolated and non- isolated.

Unit4

Power Electronics Interfaces for WES: Topologies of WES, design considerations for wind energy Switch rectifier/inverter system, Power Converters for Doubly Fed Induction Generators (DFIG) in Wind Turbines.

Power Electronics Interfaces for Fuel Cells: Types of fuel cells, Proton Exchange Membrane (PEM) fuel cell: features and operational characteristics, Design of DC-DC converters for PEM fuel cell, MPPT in Fuel Cell.

Suggested Books:

1. Mohan N, Undel and T M, Robbins W P, "Power Electronics, Converters, Applications & Design", Wiley India Pvt. Ltd.
2. Bose B K, "Modern Power Electronics and AC Drives", Pearson Education.
3. Joseph Vithayathil,"Power Electronics", Tata McGraw Hil.
4. Amirnaser Yezdani, and Reza Iravani, "Voltage Source Converters in Power Systems: Modelling, Control and Applications", IEEE John Wiley Publications.
5. Solanki C S, "Solar Photo Voltaic", PHI learning Pvt Ltd.

CO-PO Mapping Matrix for Course MTech/EE/1/DSC1**(ii)**												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	2	-	1	-	-	-	1	1
CO2	1	2	1	-	-	-	-	1	-	1	-	-
CO3	1	2	-	1	-	-	-	1	1	2	-	-
CO4	1	2	1	-	1	-	-	-	2	1	-	-

MTech/EE/1/DSC1(iii) Smart Grid							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the knowledge of smart Grid and its advantages over conventional grid
Course Outcomes: After completion of course students will be able to	
CO1	To impart knowledge about Smart Grids and Appreciate the difference between smart grid & conventional grid
CO2	To acquaint students with the phenomenon of smart metering concepts to industrial and commercial installations
CO3	To impart knowledge to students about Formulate solutions in the areas of smart substations, distributed generation and wide area measurements
CO4	To let student understand microgrid and related issues..

UNIT-1

Introduction to Smart Grid, Evolution of Electric Grid Concept of Smart Grid, Definitions Need of Smart Grid, Concept of Robust & Self-Healing Grid, Present development & International policies in Smart Grid. Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources Power Quality Conditioners for Smart Grid

UNIT-2

Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS) Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation. Cyber Security for Smart Grid

UNIT-3

Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU)

UNIT-4

Concept of micro-grid, need & applications of micro-grid, formation of micro-grid, Issues of interconnection, protection & control of Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel-cells, micro-turbines Captive power plants, Integration of renewable energy sources

Suggested Books:

1. Keyhani A, “Design of smart power grid renewable energy systems”, Wiley IEEE.
2. Berger L T, Iniewski K, “Smart Grid: Applications, Communications and Security”, Wiley.
3. Gellings C W., “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press.
4. Ekanayake J B, Jenkins N, Liyanage K, Yokoyama A, “Smart Grid: Technology and Applications”, Wiley.
5. Borlase S, “Smart Grid: Infrastructure, Technology and solutions”, CRC Press.
6. Phadke A G, “Synchronized Phasor Measurement and their Applications”, Springer.

CO-PO Mapping Matrix for Course MTech/EE/1/DSC1(iii)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	2	-	1	-	-	-	1	1
CO2	1	2	1	-	-	-	2	1	2	1	-	-
CO3	2	3	-	1	-	-	-	1	1	2	-	-
CO4	1	2	1	-	3	-	-	-	2	1	-	-

MTech/EE/1/DSC2(i) Bio-Medical Signal & Image Processing							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	This course will look at Biomedical signal and Image for understanding and their processing assessing
Course Outcomes: After completion of course students will be able to	
CO1	Understand different types of biomedical signal and Identify and analyse different biomedical signals.
CO2	Understand basics of Image processing and its methods
CO3	To emphasize and analysis of Clustering and Classification
CO4	To study different types of bio signals and their processing

Unit-1

Signals and Biomedical Signal Processing: Introduction and overview, Analog, discrete and digital signals, Processing and transformation of signals, Signal processing for feature extraction, Characteristics of digital Images, Fourier transform: Properties of One-Dimensional Fourier Transform, Discrete Fourier Transform.

. **Unit-2**

Image Processing: Image filtering Enhancement and Restoration, Point processing, Mask processing: linear filtering in Space domain, Frequency-domain filtering, Smoothing and sharping filters in frequency domain, Wavelet transform, FFT to STFT, One-Dimensional Continuous and discrete Wavelet Transform, Image processing methods.

Unit-3

Clustering and Classification: Clustering versus Classification, Feature extraction, Biomedical and. Biological features, Signal and Image processing features, K-means: A Simple Clustering Method, study of different types of Classifiers for signal processing.

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Unit-4

Processing of Biomedical Signals: Electric activities of Cell, Electric data acquisition, Electrocardiogram: Signal of Cardiovascular system, Processing and feature extraction of ECG, Electroencephalogram, Signal of the brain, Processing and feature extraction of EEG, Electromyogram: Signal of muscles, Processing and feature extraction of EMG. Frequency and wavelet-domain analysis.

Suggested Books:

1.KayvanNajarian& Robert Splinter, "Introduction to Biomedical signal and Image Processing", CRC Press
2.MetinAkay "Time Frequency & Wavelets in Biomedical Signal Processing", Wiley-IEEE Press.
3. Amine Nait-Ali, "Advanced Biomedical Signal Processing", Springer.

CO-PO Mapping Matrix for Course MTech/EE/1/DSC(i)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	1	-	1	-	-	-	1	1
CO2	1	2	1	-	-	-	2	1	-	1	-	-
CO3	2	1	-	1	-	-	-	1	1	1	-	-

CO4	1	2	1	-	1	-	-	-	-	1	-	1

MTech/EE/1/DSC2(ii) Advanced Digital Signal Processing							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the knowledge of LTI system and designing of different types of Filters**.**
Course Outcomes: After completion of course students will be able to	
CO1	To impart knowledge about LTI system and DFT.
CO2	To acquaint students with the study and design of FIR filters.
CO3	To impart knowledge to students about study and design of IIR filters.
CO4	To let student understand the concept and design of adaptive digital filters and power spectrum estimation.

UNIT-1

Introduction of DSP: Introduction to Signal Processing, Discrete Linear Systems, superposition Principle, UNIT-Sample response, stability & causality Criterion.

Fourier Transform & inverse Fourier transform: Frequency domain design of digital filters, Fourier transform, use of Fourier transform in Signal processing. The inverse fourier transform, sampling continuous function to generate a sequence, Reconstruction of continuous -time signals from Discrete-time sequences.

UNIT-2

Digital Filter Structure & Implementation: Linearity, time invariance & causality, the discrete convolution, the transfer function, stability tests, steady state response, Amplitude & Phase Characteristics, stabilization procedure, Ideal LP Filter, Physical reliability & specifications. FIR Filters, Truncation windowing & Delays, design example, IIR Filters:Review of design of analog filters & analog frequency transformation. Digital frequency transformation. Design of LP filters using impulse invariance method, bilinear transformation, Phase equalizer, digital all pass filters.

UNIT-3

Implementation of Filters: Realization block diagrams, Cascade & parallel realization, effect of infinite-word length,transfer function of degree 1&2, Sensitivity comparisons, effects of finite precision arithmetic on Digital filters.

UNIT-4

DFT & FFT & Z transform with Applications: Discrete Fourier transform, properties of DFT, Circular Convolution, Fast Fourier Transform, Realizations of DFT. The Z-transform, the system function of a digital filter, Digital Filter implementation from the system function, the inverse Z- transform, properties & applications, Special computation of finite sequences, sequence of infinite length & continuous time signals, computation of Fourier series & time sequences from spectra.

Suggested Books:

1. J G Proakis, “Digital Signal Processing using Matlab”, Pearson Education.
2. Alam V. Oppenheim and Ronald W. Schafer, “Digital Signal Processing” Pearson Education.
3. Rabiner & Gold, “Major Test& application of digital Signal Processing”, Pearson Education
4. Roman kuc, “Introduction to Digital Signal Processing,” Tata McGraw Hill Edition.
5. Richard G. Lyons, “Understanding Digital Signal Processing”, Pearson Education.
6. Paulo S. R. Diniz, Eduardo A. B. da Silva, Sergio L. Netto, “Digital Signal Processing: System Analysis and Design”, Springer.
7. Manolakis G Demitries, “Applied Digital Signal Processing”, Cambridge Univ. Press.

CO-PO Mapping Matrix for Course MTech/EE/1/DSC2(ii)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	2	-	1	-	-	-	1	1
CO2	1	2	1	-	-	-	2	1	2	1	-	-
CO3	2	3	-	1	-	-	-	1	1	2	-	-
CO4	1	2	1	-	3	-	-	-	2	1	-	-

MTech/EE/1/DSC2(iii) Bio-Medical Instrumentation							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the knowledge of different types of Biomedical Instruments with their controls.
Course Outcomes: After completion of course students will be able to	
CO1	Understand the different types of biomedical transducer for signal measurement and recording.
CO2	Understand basics of blood pressure, blood flow and respiratory system measurements.
CO3	Understand the muscoskeletal and nervous system and their measurement.
CO4	To emphasize and analysis of recent trends in biomedical Engg and safety measurement.

Unit-1

Characteristics of Transducers and Electrodes for Biological Measurement: Introduction to human body, block diagram, classification, various physiological events and suitable transducer for their recording, bioelectric potentials.

Cardiac system: Cardiac musculature, Electro cardiography, ECG recording, phonocardiography, holter recording ECG lead system, Heart rate meter, vector cardiography, pacemakers,

Unit-2

Blood pressure and Blood flow measurement; Invasive and non-invasive methods of blood pressure, characteristics of blood flow and heart sound, Cardiac output measurement, Plethysmography.

Respiratory system: Mechanics or breathing, parameters of respiration, Respiratory system measurements,respiratory therapy instruments.

Unit-3

Muscoskeletal Systems; EMG, Clinical applications, Muscles stimulator, Instrumentation for measuring Nervous function; EEG signal, frequency band classification, Lead systems, EEG recording, Clinical applications of EEG signal, X-ray CT scan, MRI, PET.

Clinical Laboratory Instrumentation; Test on blood cell, Blood cell counter, Blood glucose monitors, auto analyzer, pulse-oximeter.

Unit-4

Recent Trends in Biomedical Engg: Patient care and monitoring, Non-invasive diagnostic instrumentation, biotelemetry, telemedicine, prosthetic devices, lie detector test, Application of lasers and ultrasonic in biomedical field.

Troubleshooting and Electrical safety of Biomedical instruments; Physiological effect of current and safety measurement.

Suggested Books:

1.W T Wester, J G Tompkins, “Design of Microprocessor based Medical Instrumentation”, Englewood cliffs
2.Tatsuo, Togato & Toshiya, “Biomedical transducers and instruments”, CRC Press
3. Joseph P Bronzino, “The Biomedical engineering handbook”, CRC Press

CO-PO Mapping Matrix for Course MTech/EE/1/DSC2(iii)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	1	-	1	-	-	-	1	1
CO2	1	2	1	-	-	-	2	1	-	1	-	-
CO3	2	1	-	1	-	-	-	1	1	1	-	-
CO4	1	2	1	-	1	-	-	-	-	1	-	1

MTech/EE/1/CC3 Research Methodology and IPR							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	To enable students to Research Methodology and IPR for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.
Course Outcomes: After completion of course students will be able to	
CO1	Understand research problem formulation.
CO2	Analyze research related information
CO3	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
CO4	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

Unit 1

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

Unit 2

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

Unit 3

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

Unit 4

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

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

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'.
2. C.R. Kothari, "Research Methodology: Methods & Techniques, 2nd edition or above, New Age Publishers.
3. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
4. Ranjit Kumar, 2 nd Edition , "Research Methodology: A Step by Step Guide for beginners"
5. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
6. Mayall , "Industrial Design", McGraw Hill, 1992.
7. Niebel , "Product Design", McGraw Hill, 1974.
8. Asimov , "Introduction to Design", Prentice Hall, 1962.
9. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New TechnologicalAge", 2016.

CO-PO Mapping Matrix for Course MTech/EE/1/CC3												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	1	-	1	-	-	2	-	1
CO2	3	2	1	-	1	-	2	-	-	1	-	-
CO3	2	3	-	2	-	-	1	1	2	1	-	-
CO4	3	2	1	-	1	-	1	-	-	1	-	1

MTech/EE/1/CC4 Instrumentation & Control Lab							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Practical	02	04	Lab Work	50	-	3 Hours	TEE/ Practical File

Course Objective	The main Outcome of the course is to impart the students with the knowledge of how to create, simulate and measure the different applications in VI.
Course Outcomes: After completion of course students will be able to	
CO1	To impart knowledge about mathematical, Boolean operations, half adder.
CO2	Understand how to create the VI for decimal to binary conversion, array function, sequence structure. Also studying the properties and options of graphs/charts.
CO3	To impart knowledge about measurement of temperature, strain and power using VI.
CO4	Understand to create model for speed control of DC motor, analysis of PID controller.

Following experiments (at least 10) are required to be performed in MATLAB/ETAP/LabView or equivalent:

1. Find addition, subtraction, multiplication and division of two numeric inputs
2. Perform various Boolean operations (AND, OR, NAND, NOR, XOR).
3. Add two binary bits and find the sum and carry (half adder).
4. Create a Vito find the decimal equivalent of a binary number using sub VI.
5. Create VI for studying array functions.
6. Create VI for studying sequence structure.
7. Create VI for studying properties and options of graphs/charts.
8. Measurement of Temperature using Virtual instrumentation.
9. Measurement of Strain using Virtual instrumentation.
10. ImplementationofVI to control the speed of a DC motor.
11. RealTime Power measurement and analysis using Virtual instrumentation.
12. Creating Models, Simulation and Analysis of PID Controller.
13. Study and Implementation of Displacement Transducers.

CO-PO Mapping Matrix for Course MTech/EE/1/CC4												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	-	1	-	-	-	1	1
CO2	1	2	1	-	-	-	1	1	2	1	-	-
CO3	1	2	-	1	-	-	-	1	1	1	-	-
CO4	1	2	1	-	1	-	-	-	2	1	-	-

MTech/EE/1/CC5 Advanced Power System Lab-I							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Practical	02	04	Lab Work	50	-	3 Hours	TEE/ Practical File

Course Objective	The main Outcome of the course is to impart the students with the knowledge of programming for various types of power system appliances.
Course Outcomes : After completion of course students will be able to	
CO1	To impart knowledge about a program to develop Bus Admittance Matrix, power flow studies using Newton-Raphson and Gauss-Siedel method.
CO2	Understand how to determine the generalized constants A, B, C, D of a long transmission line and voltage & current for three phase faults ona2-buspowersystem
CO3	To impart knowledge about simulation and analysis of a single phase & three phase power system and generation, transmission & distribution in power system.
CO4	To impart knowledge about simulation and analysis of different fault condition and contingency concept in a power system.

Following experiments are required to be performed in MATLAB/ETAP/LabView or equivalent.

1. Write a program to develop Bus Admittance Matrix Y_{BUS}.
2. Write a program for the Power Flow Studies using N-R(Newton-Raphson) method.
3. Write a program for the power flow analysis of system using Gauss-Siedel Technique.
4. Determination of the generalized constants A, B, C, D of a long transmission line.
5. Determination of the voltage and current for three phase faults on a 2-bus power system.
6. Simulation and Analysis of a single phase & three phase power system.
7. Simulation & Analysis of generation, transmission & distribution in power system.
8. Simulation & Analysis of different fault condition in power system.
9. Simulation and Analysis of 9-bus power system.
10. Simulation and Analysis of contingency concept in a power system.

CO-PO Mapping Matrix for Course MTech/EE/1/CC5												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	-	1	-	-	-	1	1
CO2	1	2	1	-	-	-	1	1	2	1	-	-
CO3	1	2	-	1	-	-	-	1	1	1	-	-
CO4	1	2	1	-	1	-	-	-	2	1	-	-

MTech/EE/2/CC6 Advanced Power System Protection							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the knowledge of advanced protection system in modern power system.
Course Outcomes: After completion of course students will be able to	
CO1	To impart knowledge about need of protection system and various issues of CT and PT
CO2	To acquaint students with the comparators and relays.
CO3	To impart knowledge to students about distance protection and protection of feeders, generators and motors.
CO4	To let student understand protection of transformers, buses and modern protection system.

Unit1

Introduction: Need for protective systems, Zones of protection, classification of protective relays, electromechanical, solid state and digital relays, comparisons between different types of relays.

Current transformers and potential transformers: construction, operating principle and their performance

Unit2

Comparators: general equation of comparators, Analysis for amplitude comparator, analysis for phase comparator, duality between amplitude and phase comparators.

Over current relays, differential relays, operating and restraining characteristics, distance relays, impedance relays, reactance relays, and mho relay quadrilateral relays, elliptical relays, comparison with conventional relays.

Unit3

Distance protection: Principle of distance relaying, time grading of distance relays, schemes of distance protection, distance protection by impedance, reactance and mho relays, Effect of power swings on the performance of distance relays.

Pilot relaying schemes: Pilot wire protection, carrier current protection.

Protection of Generators and Motors: Types of faults, Stator and rotor protection against various types of faults.

Unit4

Protection of Transformers: Types of faults, differential protection schemes, harmonic restraint relay, over flux protection, Earthing transformer protection.

Bus Zone Protection: Types of Bus-bar faults, differential current protection frame leakage protection. Microprocessor based protective relays: Over current relay, impedance relay, reactance relay, mho relay, microprocessor based distance relaying.

Application of artificial intelligence and wavelet transform in protective relays

Suggested Books:

1. TSM Rao, "Power System Protection–Static Relays", Tata McGraw Hill Education Pvt. Ltd.
2. B. Bhalja, R P Maheshwari and N G Chothani, "Protection and Switchgear", Oxford University Press.
3. Ravinder Nath & Chander, "Power System Protection and Switchgear", New Age International Publishers.
4. Badri Ram & Vishwakarma, "Power system protection and switch gear" McGraw Hill Education(India)
5. C L Wadhwa, "Electrical Power Systems", New Age International Publishers.
6. Protective Relays –Their Major Test and Practice Vol. I & II by W. Van Warrington.
7. Advanced power system analysis and dynamics by L P Singh: Wiley Eastern N. Delhi.
8. Digital Protection: Protective relay from Electro Mechanical to Microprocessor, L P Singh: Wiley Eastern.
9. Switchgear and protection by S S Rao: Khanna Pub

CO-PO Mapping Matrix for Course MTech/EE/2/CC6												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	1	-	2	-	-	-	1	1
CO2	3	2	2	-	2	2	1	1	2	1	2	-
CO3	3	2	-	1	-	-	-	3	1	1	-	1
CO4	2	2	1	-	2	-	-	-	2	1	1	1

MTech/EE/2/CC7 Intelligent Control							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	This course will look at **different types of Intelligent controls.**

Course Outcomes (CO)	
After completion of course students will be able to	
CO1	Understand reasoning and apply the ANN models to different problems.
CO2	Understand reasoning and apply the learning scheme to different problems.
CO3	Understand reasoning and apply the Fuzzy system to different problems.
CO4	Understand reasoning and apply the Genetic & PSO algorithm to different problems.

Unit-1

ANN Models & Architecture:

Biological foundations, ANN models, Types of activation function, introduction to network architecture, multilayer feed forward network (MLFFN), Kohonen self-organizing map, radial basis Function network (RBFN), recurring neural network.

Unit-2

Learning Processes:

Supervised and unsupervised learning, error-correction learning, Hebbian learning, Boltzman learning, single layer and multilayer perception model, least mean square algorithm, back propagation algorithm, Application in forecasting and pattern recognition and other engineering problems.

Unit-3

Fuzzy Control System:

Fuzzy sets, fuzzy set operations, properties, membership functions, fuzzy to crisp conversion, measures of fuzziness, fuzzification and defuzzification methods, application in engineering problems. Simple fuzzy logic controllers with examples, special forms of fuzzy logic models, classical fuzzy control problems.

Unit-4

Genetic & PSO Algorithm:

Genetic Algorithm: Types of reproduction operators, crossover & mutation Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP, Simulated Annealing Algorithm, Particle Swarm Optimization (PSO) - Graph Grammer Approach - Example Problems

Suggested Books:

1. M. T. Hagon, Howard B. Demuth and Mark Beale, “Neural Network Design”, PWS Publishing.
2. Jacek M Zurada, “Introduction to Artificial Neural Systems”, Jaico Publishing House, Bombay.
3. Wasserman, “Neural Computing: Major Test and Practice”, Van Nastr and Reinhold.
4. Freeman “Neural Networks-Algorithms, application and programming techniques”, Pearson Education.

CO-PO Mapping Matrix for Course MTech/EE/2/CC7												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	-	2	-	1	-	-	-	2	2
CO2	3	2	1	-	2	-	2	1	-	1	-	-
CO3	2	1	-	1	1	-	2	1	1	2	-	-
CO4	3	2	3	-	2	-	2	-	2	1	-	-

MTech/EE/2/DSC3(i) HVDC Transmission & FACTS Devices							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the knowledge of HVDC and FACTS devices.
Course Outcomes (CO)	
After completion of course students will be able to	
CO1	To impart knowledge about HVDC transmission system.
CO2	To acquaint students with the interaction of AC and DC system and various links.
CO3	To impart knowledge to students about facts devices.
CO4	To let student understand compensation system and control techniques.

Unit 1

HVDC Transmission: Development of HVDC Technology, Selection of converter configuration. Rectifier and Inverter operation. Control of HVDC converters and Systems.

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

Unit 2

Interaction between HVAC and DC systems – Voltage interaction, over voltages on AC/DC side, Harmonic instability problems and DC power modulation.

Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

Unit 3

Introduction of Facts Concepts: Basic of flexible alternating current transmission system (FACTS) controllers, shunt, series, combined and other controllers, HVDC or FACTS, static VAR compensator (SVC) and static synchronous compensator (STATCOM), Static Synchronous Series Compensator (SSSC), Thyristor Controlled Series, Capacitor (TCSC). Solid State Contactors (SSC) and TSSC.

Unit 4

Combined Compensators: Introduction, Unified power flow controller (UPFC), conventional power control capabilities, real and reactive power flow control, comparison of UPFC to series compensators, control structure, dynamic performance. Interline power flow controller (IPFC) basic operating principles, control structure, application considerations.

Suggested Books:

1. Hingorani N.G, "Understanding FACTS (Concepts and Technology of Flexible AC Transmission System)", Standard Publishers.
2. Song Y.H. and Johns A.T., "Flexible AC Transmission Systems", IEEE Press.
3. Ghosh A. and Ledwich G., "Power Quality Enhancement using Custom Power Devices", Kluwer Academic Publishers.
4. Mathur R.M. and Verma R.K., "Thyristor based FACTS controllers for Electrical Transmission Systems", IEEE Press.
5. Bollen M.H.J., "Understanding Power Quality and Voltage Sag", IEEE Press.
6. Padiyar K.R., "FACTS Controllers in Power Transmission and Distribution", New Age International Publisher.
7. Miller T.J.E., "Reactive Power Control in Electric Systems", John Wiley.
8. Kamakshaiah S, Kamaraju V, "HVDC Transmission", McGraw Hill Education.

CO-PO Mapping Matrix for Course MTech/EE/2/DSC3(i)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	2	-	1	-	-	-	1	1
CO2	1	2	1	-	1	-	2	1	2	1	-	1
CO3	2	3	-	1	-	-	2	1	1	2	2	-
CO4	1	2	1	-	3	-	-	1	2	1	-	1

MTech/EE/2/DSC3(ii)
Transients in Power System

Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the knowledge of transients in power system.

Course Outcomes (CO)	
After completion of course students will be able to	
CO1	To impart knowledge about different types of factors effecting power quality.
CO2	To acquaint students with the transients and lightning.
CO3	To impart knowledge to harmonics.
CO4	To let student understand about distributed generation and various issues related to power quality.

UNIT-1

What is Power Quality, Power Quality is Equal to Voltage Quality, Why are we concerned about Power Quality, Voltage Imbalance, Waveform Distortion, Voltage Fluctuation, Power Frequency Variations, Power Quality Terms, Sources of Sags and Interruption, Estimating Voltage Sag Performance, Area of Vulnerability, Equipment Sensitivity of Voltage Sags, Transmission Systems Sag Performance Evaluation, Utility Distribution System Sag Performance Evaluation.

UNIT-2

Sources of Transient Overvoltage's: Capacitor Switching, Restrike during Capacitor Deenergizing, Lightning, Ferro - resonance, Other Switching Transients. Principles of Overvoltage Protection.
Devices for Overvoltage Protection: Surge Arresters and Transient Voltage Surge Suppressor, Isolation Transformers, Utility System Lightning Protection, Shielding, Line Arresters, Low Side Surges, Cable Protection, Scout Arrester Scheme, Computer Tools for Transient Analysis.

UNIT-3

Fundamentals of Harmonics: Harmonic Distortion, Voltage vs Current Distortion, Harmonics vs Transients, PowerSystem Quantities Under Non Sinusoidal Conditions, Active, Reactive and Apparent Power, Power Factor: Displacement and True, Harmonic Phase Sequences, Triplen Harmonics.
Harmonic Sources from Commercial Loads: Single Phase Power Supplies, Fluorescent Lighting, Adjustable Speed Drives for HVAC and Elevators.
Effects of Harmonic Distortion: Impact on Capacitors, Impact on Transformers, Impact on Motors, Impact on Telecommunications, Impact on Energy and Demand Metering.

UNIT-4

Distributed Generation and Power Quality: Resurgence of DG, Perspectives on DG Benefits, Perspectives on Interconnection, DG Technologies, Fuel Cells, Wind Turbines, Photovoltaic Systems, Interface to the Utility System, Synchronous Machines, Asynchronous Machines, Electronic Power Inverters, Power Quality Issues, Voltage Regulation, Harmonics, Voltage Sags, Operating Conflicts, Voltage Regulation Issues, Islanding, Transformer Connections.

Suggested Books:

1. R C Dugan, M F McGranaghan, S Santoso, H. Wayne Beaty, "Electrical Power System Quality", McGraw Hill.
2. Akihiro Ametani, Naoto Nagaoka, Yoshihiro Baba, Teruo Ohno, "Power System Transients: Theory and Applications", CRC Press.
3. L.V. Bewley, "Traveling waves in Transmission Systems", Dover.
4. R. Rudenberg, "Electric Stroke waves in Power Systems", Harvard University Press, Cambridge, Massachusetts.
5. Allan Greenwood, "Electric Transients in Power Systems", Wiley Interscience.
6. CS Indulkar and DP Kothari, "Power System Transients, Statistical Approach", PHI Pvt Ltd., New Delhi.
7. VA Venikov, "Transient phenomena in Electrical Power Systems", Pergamon Press, London.
8. Klaus Ragaller, "Surges in High Voltage Networks", Plenum Press, New York.
9. Pritindra Chowdhari, "Electromagnetic transients in Po r System", John Wiley and Sons Inc.

10. Naidu M S and Kamaraju V, “High Voltage Engineering”, TMH Publishing Company Ltd., New Delhi.

CO-PO Mapping Matrix for Course MTech/EE/2/DSC3(ii)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	2	-	1	-	-	-	-	-
CO2	1	2	1	2	-	-	2	1	-	1	1	1
CO3	2	1	2	1	-	-	-	1	1	-	2	1
CO4	1	2	1	-	2	-	-	-	2	1	-	1

MTech/EE/2/DSC3(iii) Advanced Power Distribution & Automation							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the knowledge of electricity distribution and automation.
Course Outcomes (CO)	
After completion of course students will be able to	
CO1	To impart knowledge about distribution automation.
CO2	To acquaint students with the control and intelligent system in distribution automation.
CO3	To impart knowledge to students about renewable energy resources and distribution management.
CO4	To let student understand communication system implementation in distribution system.

UNIT-1

Introduction: General Concept, Distribution of Power, Power Loads, Connected Loads.

Load Forecasting: Concept of Statistics, Regression Analysis, Correlation Theory, Factor in Power System Loading, Unloading the System, Forecast of System peak.

UNIT-2

System Planning: Planning Process, Basic Principle in system planning, System Development, Overview of Distributed generation, Different types of mapping: Global positioning System GPS, Automated mapping AM/Facility Management FM.

Introductory Methods in Power System Planning: Per Unit Calculation, Matrix Algebra, Symmetrical Components, Overview of Load Flow, Automated Planning: software needs, Data, solution techniques (Gauss Iterative method, Gauss seidel iterative method, Newton Raphson iterative method, Improved newton Raphson method) Effect of Abnormal Loads.

UNIT-3

Brief introduction of Distribution Automation, Role of PLC & SCADA in substation and distribution automation, Consumer information Service (CIS), Geographical information system GIS, Automatic meter Reading (AMR), Automation System.

UNIT-4

Metering System: Different types of Meter, Metering system component, Ferraris Meters, Solid state meters, Advance meter Infrastructure Systems (AMI).

Overview of Net metering, Meter current Rating, Prepaid Electricity meters, Meter selection and Location, testing methods.

Suggested Books:

1. A. S Pabla, “Electric Power Distribution”, McGraw Hill Education.
2. James A. Momoh, “Electric Power Distribution Automation Protection and Control”, CRC Press.
3. James N-Green and R Wilson, “Control and Automation of electric Power Distribution Systems”, CRC Press.
4. Turan Gonen,“Electric Power Distribution System Engineering”, CRC Press.
5. Abdelhay A. Sallam, “Electric Distribution Systems”,Wiley-IEEEPress.

CO-PO Mapping Matrix for Course MTech/EE/2/DSC3(iii)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	2	1	1	1	-	1	2	1
CO2	1	2	1	-	-	-	2	1	2	1	-	-
CO3	2	3	-	1	-	2	-	1	1	1	1	1
CO4	1	2	1	-	3	1	-	-	2	1	-	-

MTech/EE/2/DSC4(i) Digital Control System							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance
Course Objective	The main Outcome of the course is to impart the students with the knowledge of digital control system.						
Course Outcomes (CO)							
After completion of course students will be able to							
CO1	To impart knowledge about signal processing in digital control system.						
CO2	To acquaint students with the control devices and systems.						
CO3	To impart knowledge to students about state variables, controllability and observability.						
CO4	To let student understand the various concepts of digital observers.						

Unit-1

Signal Processing in Digital Control: Basic digital control scheme, principle of signal conversion, basic discrete-time signal, time-domain model for discrete-time systems, z-transform, transfer function models, jury stability criterion, sample and hold systems, sample spectra and aliasing

Unit-2

Models of Digital Control Devices and Systems: Introduction, z-domain description of sampled continuous-time plants, z-domain description of systems with dead-time, implementation of digital controllers, digital PID controllers, digital temperature control system, stepping motors and their control, PLC

Unit-3.

Analysis using State Variable Methods: State variable representation-concepts, modeling, transformation, state diagrams, Jordan canonical form, Eigen values and Eigenvectors,

Solution of state equations, concepts of controllability and Observability,

Unit-4

Digital Observers: State regulator design-full order and reduced order state observer, design of state observers, compensator design by separation principle, state feedback with integral control , deadbeat control by state feedback and deadbeat observers

Suggested Books:

1. Ogata K," Discrete time Control Systems", Pearson Education.
2. Nagrath and Gopal, "Control System Engineering", New Age International.
3. Kuo B C, "Digital Control Systems", Oxford University Press.
4. Goapl, "Digital Control & State Variable Method", McGraw Hill Education.

CO-PO Mapping Matrix for Course MTech/EE/2/DSC4(i)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	2	-	1	1	-	1	2	-
CO2	1	2	1	-	1	2	2	1	2	1	-	-
CO3	3	2	-	1	1	-	-	1	1	2	-	1
CO4	2	2	2	-	2	-	-	2	2	1	-	-

MTech/EE/2/DSC4(ii) Advanced Microprocessors							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the knowledge of advanced microprocessor.

Course Outcomes (CO)	
After completion of course students will be able to	
CO1	To impart knowledge about 8086 microprocessors.
CO2	To acquaint students with the interfacing converters etc.
CO3	To impart knowledge to students about microcontrollers.
CO4	To let student about application of microprocessor and various controllers related to it.

UNIT-1

Architecture of 8086 microprocessor, Memory Addressing, Bus Timings for MN/MX mode, interrupt structure. Memory Interfacing and Addressed encoding techniques for 8086 microprocessor

UNIT-2

Addressing modes, Instruction set and application programs, Assembler Directives, Programming Techniques using TASM, Interfacing D/A and A/D converters using programmable I/O devices, Interfacing Stepper motor. Architecture of INTEL X86 Family: CPU block diagrams, Pin diagrams and internal descriptions of 80286, 386, 486 and Pentium Processor, Instruction formats.

UNIT-3

Introduction to micro controllers, Architecture of 8051microcontroller, basic Instruction set, programming, serial data communication, inter facing with D/A and A/D converters.

UNIT-4

Application of Microprocessors, A Microcomputer-based Industrial Process-control System, Hardware for Control Systems and Temperature Controller, Overview of Smart-Scale Operation.

Suggested Books:

1. Hall D V, “Microprocessors & Interfacing”, McGraw Hill Education.
2. Brey B, “The Intel Processors”, Pearson Education.
3.Gibson, “Microprocessors”,, Prentice Hall of India.
4. Jean Loup Baer, “Microprocessor Architecture”, Cambridge University Press.
5. Ayala K J, “Micro Controller”, Penram International

CO-PO Mapping Matrix for Course MTech/EE/2/DSC4(ii)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	1	1	-	1	-	1	1
CO2	1	1	1	-	1	-	2	1	2	1	1	1
CO3	2	3	-	1	-	-	-	1	1	2	-	-

CO4	1	2	1	-	3	-	1	1	2	1	1	1

MTech/EE/2/DSC4(iii) Reliability Engineering							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the concept of Reliability Engineering and its application in Engineering**.**

Course Outcomes (CO)	
After completion of course students will be able to	
CO1	To emphasize and analysis of basic of reliability engineering.
CO2	To understand the concept of Fault tree analysis in reliability.
CO3	To understand the concept of Maintainability Analysis in reliability.
CO4	To study the concept of Artificial Intelligence in reliability engineering.

Unit-1

Review of basic concepts in Reliability Engg., Reliability function, different reliability models, etc. Reliability evaluation techniques for complex systems; Tie set and cut set approaches, different reliability measures, Reliability allocation/apportionment, reliability improvement, redundancy optimization techniques.

Unit-2

Fault tree analysis: fault tree construction, simplification and evaluation, importance measures, modularization, applications, advantages and disadvantages of fault tree techniques.

Unit-3

Maintainability Analysis: measures of system performance, types of maintenance, reliability centred maintenance, reliability and availability, evaluation of engine ring systems using Markov models.

Unit-4

Applications of fuzzy Major Test and neural networks to Reliability Engineering. Reliability testing, design for reliability and maintainability. Typical reliability case studies.

Suggested Books:

1. R. Rama Kumar, “Engineering Reliability”, Prentice Hall.
2. K B Mishra, “Reliability Analysis & Prediction”.
3. K B Mishra, “New trends in System Reliability Evaluation”.
4. M L Shooman, “Probabilistic reliability–an engineering approach”, R E Krieger Pub.
5. K K Aggarwal, “Reliability Engineering”.
6. Roy & Billington, “Reliability Engineering”.
7. Balagurswami, “Reliability Engineering”, McGraw Hill Education.

CO-PO Mapping Matrix for Course MTech/EE/2/DSC4(iii)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	3	1	2	-	1	-	1	-	-	1
CO2	1	2	1	2	-	-	-	1	2	1	2	1
CO3	2	2	1	3	-	1	2	1	1	2	1	2

CO4	3	2	2	2	1	-	1	-	2	1	-	2

MTech/EE/2/CC8 Modeling & Simulation Lab							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Practical	02	04	Lab Work	50	-	3 Hours	TEE/ Practical File

Course Objective	The main Outcome of the course is to impart the students with the knowledge of modelling and simulation of different types of applications.

Course Outcomes (CO)	
After completion of course students will be able to	
CO1	To impart knowledge about to preform Thevenin's ,Norton's,& Superposition theorem and Avg. & R. M. S. value of R L C different R, L and C circuit.
CO2	To impart knowledge about to preform half and full wave rectifier with different R, L and C load for both single and three phase.
CO3	To impart knowledge about to preform different types of power electronics component mainly inverter and chopper.
CO4	To impart knowledge about to preform speed and torque control of DC and AC motors.

Following experiments (at least 10) are required to be performed in MATLAB/ETAP/LabView or equivalent.

1. To verify Thevenin's, Norton's & Superposition theorem.
2. To find Average & RMS value of (V-I) of RLC series & parallel; series parallel RC-RL circuit.
3. To perform1-ϕ (half & full) wave rectifier with (R, R-L & R-C) load.
4. To perform 3-ϕ (half & full) wave rectifier with (R, R-L & R-C) load.
5. To find Average RMS.&T.H.D. of 1-ϕ (half & full) wave inverter with (R & R-L) load.
6. To find Avg., R.M.S.&T.H.D. of 3-ϕ (half & full) wave inverter with (R & R-L) load.
7. To perform current source inverter (C.S.I.) & PWM inverter.
8. To perform step down (BUCK)& step up (BOOST) chopper.
9. To perform Type (A, B, C & D) chopper.
10. To perform Field & Armature control of separately excited DC motor.
11. To perform Field & Armature control of DC series & DC shunt motor.
12. To perform 3-ϕ Induction Motor with constant & variable torque.
13. To perform speed control of 3-ϕ Synchronous motor with constant & variable torque.

CO-PO Mapping Matrix for Course MTech/EE/2/CC8												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	2	1	1	1	-	-	2	1	1
CO2	3	2	1	-	-	1	1	1	2	1	-	-
CO3	1	2	2	1	-	2	-	1	1	1	1	1
CO4	1	2	1	-	1	-	1	-	2	1	-	1

MTech/EE/2/CC9 Advanced Power System Lab-II							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Practical	02	04	Lab Work	50	-	3 Hours	TEE/ Practical File

Course Objective	The main Outcome of the course is to impart the students with the knowledge of programming for various types of power system appliances.
Course Outcomes (CO)	
After completion of course students will be able to	
CO1	To impart knowledge the simulation& analysis of the generator and transformer protection.
CO2	To impart knowledge the simulation& analysis of power quality improvement, different types of load.
CO3	To impart knowledge the simulation& analysis of PV cell.
CO4	To impart knowledge the simulation& analysis of different non-conventional plant biomass gasifier and wind turbine.

Following experiments are required to be performed in MATLAB/ETAP/LabView or equivalent.

1. Simulation & Analysis of the generator protection.
2. Simulation & Analysis of the transformer protection.
3. Simulation & Analysis of power quality improvement.
4. Simulation & Analysis of different types of relays in power system.
5. To perform the simulation of Photo-Electric Effect.
6. To perform the simulation to construct the PV cell to show the V-I & P-V characteristics curve of it.
7. ToperformthesimulationofPhotovoltaicpowerconversionforsingleand3-phase load on account with MPPT.
8. To perform the construction of a Simulink model of Biomass Gasifier.
9. To study mathematical modelling of DFIG based Wind Turbine and its impact on connection with grid.
10. To perform the simulation of Permanent Magnet Synchronous Generator (PMSG) based wind energy conversion system.
11. To perform the simulation of PV-Grid inter connection using MPPT technique with the partial shading effect.

CO-PO Mapping Matrix for Course MTech/EE/2/CC9												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	3	2	-	1	-	-	-	1	1
CO2	3	2	1	-	-	2	2	1	1	2	-	-
CO3	1	2	1	2	-	-	2	1	1	2	2	1
CO4	3	2	1	-	3	-	-	2	2	1	-	2

MTech/EE/3/CC10 ADVANCED ELECTRIC DRIVES & CONTROL							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the knowledge of electric drives & control in electric system.
Course Outcomes (CO)	
After completion of course students will be able to	
CO1	To study basic electric drives, types of loads, classes of motor duty.
CO2	To study different types of DC drives, stability analysis, modern control techniques.
CO3	To study mathematical modelling of induction motor drives, introduction to Cyclo-converter fed induction motor drive.
CO4	To study different types of synchronous motor drives used in mills.

UNIT 1

Introduction: Definition, Part of the electric drive, Types of loads, steady state & transient stability of Drive, state of art of power electronics and drives, thermal model of motor for heating and cooling, classes of motor duty, determination of motor rating.

UNIT 2

D.C. Drives: Review of braking and speed control of D.C. motors, multi-quadrant operation, loss minimization in adjustable speed drives. Mathematical modelling of dc drives, stability analysis, modern control techniques: variable structure, adaptive control, Chopper-Controlled DC Drives.

UNIT 3

Induction motor drives: Review of braking and speed control of induction motors, constant V/F, constant air gap flux, controlled voltage, controlled current and controlled slip operation. Mathematical modelling of induction motordrives, transient response and stability analysis Introduction to Cyclo-converter fed induction motor drive. Pulse Width Modulation for Electric Power Converters

UNIT 4

Synchronous motor drives: Adjustable frequency operation, voltage fed drive, current fed self-controlled drive. Application of electric drives in steel mills, paper mills, textile mills and machine tools etc. A. C. motor drives in transportation system and traction.

References:

1. Dubey G K, “Fundamentals of Electrical Drives”, Narosa Publishing House, New Delhi.
2. S K Pillai, “A First Course on Electrical Drives”, New Age International (P) Ltd., New Delhi.
3. Krishan R, “Electric Motor Drives: Modeling Analysis and Control”, PHI Pvt Ltd. New Delhi-2001.
4. Bose B K, “Power Electronics and Variable Frequency Drives: Technology and Applications”, IEEE Press, 1997.
5. Bose B K , “Modern Power Electronics and AC Drives”, Pearson Educational, Delhi,

CO-PO Mapping Matrix for Course MTech/EE/3/CC10												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	-	2	-	2	-	1	1
CO2	2	2	1	-	2	1	-	1	1	1	-	1
CO3	3	3	2	1	-	-	1	1	1	2	2	-
CO4	1	2	1	-	3	1	-	1	2	1	-	2

MTech/EE/OEC1

Non-Conventional Energy Resources

Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the knowledge of renewable energy resources and different factors related to them.

Course Outcomes (CO)

After completion of course students will be able to

CO1	Understand the Need, importance and scope of non conventional and alternate energy resources
CO2	To understand role significance of solar energy
CO3	To provide importance of Wind Energy
CO4	To understand the role of ocean energy in the Energy Generation.
CO5	To get the utilization of Biogas plants and geothermal energy
CO6	To understand the concept of energy Conservation.

Unit 1

SOLAR ENERGY : Solar Radiation, Measurements of Solar Radiation, Flat Plate And Concentrating Collectors, Solar Direct Thermal Applications, Solar Thermal Power Generation, Fundamentals of Solar Photo Voltaic Conversion, Solar Cells, Solar PV Power Generation, Solar PV Applications.

Unit 2

WIND ENERGY: Wind Energy Estimation, Types of Wind Energy Systems, Performance, Site Selection, Details of Wind Turbine Generator.

Unit 3

OCEAN ENERGY: Ocean Thermal Energy Conversion (OTEC), Principle of operation, development of OTEC plants, Tidal and wave energy, Potential and conversion techniques, mini-hydel power plants.

Unit 4

BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking.

Unit 5

GEOTHERMAL ENERGY: Resources, types of wells, methods of harnessing the energy, scope in India.

Reference Books:

1. Renewable Energy Sources:Twidell& Weir, CRC Press.
2.Solar Energy/ S.P. Sukhatme, Tata McGraw-Hill
3.Non Conventional Energy Systems: K M. Mittal, A H WheelerPublishing Co Ltd
4. Renewable Energy Technologies: Ramesh & Kumar, Narosa publication.
5. Biomass Energy, Oxford &IBH Publication Co.

CO-PO Mapping Matrix for Course MTech/EE/OEC1												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	2	-	1	-	-	-	1	1
CO2	2	2	1	-	-	-	-	1	1	1	-	1
CO3	2	3	-	1	-	-	-	1	1	-	-	-
CO4	3	2	1	-	3	-	-	-	2	1	-	-
CO5	1	2	1	-	-	1	1	-	1	1	-	-
CO6	3	1	2	1	-	-	-	1	-	1	2	-

MTech/EE/OEC2 Solar Energy Engineering							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the knowledge of renewable energy resources and different factors related to them.

Course Outcomes (CO)	
After completion of course students will be able to	
CO1	explain the technical and physical principles of solar cells and solar collectors
CO2	measure and evaluate different solar energy technologies through knowledge of the physical function of the devices
CO3	calculate the required size of solar cell systems and solar collectors from a given power need by using appropriate software,
CO4	make critical comparisons of different solar energy systems,
CO5	communicate technological, environmental and socio-economic issues around solar energy in a concise and an accessible way to a target group with basic technical skills.

Unit-1

Solar radiation: Properties of sunlight. Absorption by the atmosphere. Calculation of solar irradiance at surfaces.

Unit-2

Solar cells and modules: The function of solar cells from semiconductor physics. Different solar cell technologies and fabrication methods. Concepts for increasing efficiency based on loss analysis. Wavelength sensitivity. Series connection of solar cells to modules. Module function and characteristics. Shading of cells and modules.

Unit-3

System components and their functions. Calculating output and dimensioning of solar cell systems. Analysis and computer simulation of a solar cell system. Concentrated sunlight and solar power (CSP). Properties of optical concentration systems. Solar cells in concentrated sunlight. Overview of the different components in a CSP system and their functions. Examples of CSP-systems globally.

Unit-4

Solar thermal: Thermodynamic description of solar collectors. Optical properties of solar collectors and technologies for fabrication. Solar thermal systems for different applications in Sweden and abroad. Storage of solar generated heat.

Unit-5

Hybrid systems: Combinations of solar thermal and solar cell systems. Overview of different applications. District heating with solar thermal components.

Unit-6

Active solar energy in systems: How large scale deployment of active solar energy is possible in Sweden and globally. Buying and selling heat and electric energy. Grid aspects of large scale deployment of solar cells as well as environmental and socioeconomic aspects.

REFERENCES :

1. Foster .R, Ghassemi M., Cota A., "Solar Energy", CRC Press, 2010.
2. Duffie .J.A, Beckman W.A. "Solar Engineering of Thermal Processes", 3rd ed., Wiley, 2006.
3. De Vos .A, "Thermodynamics of Solar Energy Conversion", Wiley-VCH, 2008.
4. Garg .H.P, Prakash .J, "Solar Energy Fundamentals and Applications", Tata McGraw-Hill, 2005.
5. Kalogirou .S, "Solar Energy Engineering", Processes and Systems, Elsevier, 2009.

CO-PO Mapping Matrix for Course MTech/EE/OEC2												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	2	-	1	-	-	-	1	1
CO2	2	3	1	-	-	-	-	1	1	1	-	1
CO3	2	2	1	1	-	1	-	1	1	-	1	-
CO4	1	1	1	-	3	-	-	-	2	1	-	1
CO5	1	2	1	-	-	1	1	-	1	1	-	1

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MTech/EE/OEC3 Energy Management and Auditing							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to impart the students with the knowledge of renewable energy resources and different factors related to them.

Course Outcomes (CO)	
After completion of course students will be able to	
CO1	To impact concepts behind economic analysis and Load management
CO2	Energy management on various electrical equipments and metering
CO3	Concept of lighting systems and cogeneration.
CO4	Understand the methods of improving energy efficiency in different electrical systems
CO5	Understand the concepts of different energy efficient devices.

UNIT 1

I**NTRODUCTION** : Basics of Energy – Need for energy management – Energy accounting – Energy monitoring, targeting and reporting - Energy audit process. Energy management for electric motors – Transformer and reactors - Capacitors and synchronous machines, energy management by cogeneration – Forms of cogeneration – Feasibility of cogeneration – Electrical interconnection.

UNIT 2

LIGHTING SYSTEMS: Energy management in lighting systems – Task and the working space - Light sources – Ballasts – Lighting controls – Optimizing lighting energy – Power factor and effect of harmonics, lighting and energy standards.

UNIT 3

METERING FOR ENERGY MANAGEMENT: Metering for energy management – Units of measure - Utility meters – Demand meters – Paralleling of current transformers – Instrument transformer burdens – Multi tasking solid state meters, metering location vs requirements, metering techniques and practical examples.

UNIT 4

ECONOMIC ANALYSIS AND MODELS: Economic analysis – Economic models - Time value of money - Utility rate structures – Cost of electricity – Loss evaluation, load management – Demand control techniques – Utility monitoring and control system – HVAC and energy management – Economic justification.

REFERENCES :-

1. Reay D.A, Industrial Energy Conservation, 1stedition, Pergamon Press, 1977.
2. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 196.
3. Amit K. Tyagi, Handbook on Energy Audits and Management, TERI, 2003.

4. Electricity in buildings good practice guide, McGraw-Hill Education, 2016.

CO-PO Mapping Matrix for Course MTech/EE/OEC3												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	2	-	-	1	-	1	-	1	2
CO2	2	3	1	-	1	-	-	1	1	1	-	1
CO3	1	2	1	1	-	1	1	1	1	-	1	2
CO4	1	1	1	-	2	-	-	2	2	1	1	-
CO5	1	2	1	2	-	1	1	-	2	1	-	2

MTech/EE/OEC4 ENERGY EFFICIENT BUILDINGS							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Compulsory Theory	04	04	Lecture	70	30	3 Hours	TEE/MTE/ Assignment/ Attendance

Course Objective	The main Outcome of the course is to understand the modern building concept of building for sustainability.
Course Outcomes: After completion of course students will be able to	
CO1	To understand the basic concepts of indoor lighting system and energy efficiency in lighting
CO2	To understand the various passive cooling methods for buildings
CO3	Air Conditioner load estimation and energy conservation in AC systems
CO4	Understand the concept of white light generation techniques
CO5	Understand the concepts of green energy.

Unit-1

Climates and buildings: Climatic zones in India and their characteristics, Implications of climate on building design – human comfort conditions in building indoors, Urban climate and Micro climate,

Unit 2

Energy Conscious buildings: Building envelope, site, form and orientation, building components - internal and external shading devices, need for proper ventilation, Passive cooling and heating concepts for various climate zones in India- advantages and disadvantages, Air Conditioning- Estimation of heat loads – Air conditioning load calculation - Brief concept only, Chilled water system, Energy conservation techniques in air conditioning systems,

Unit 3

Lighting Design & Solid State Lighting: Lighting Design Principles, Quantity and Quality determination method of interior lighting design – general design considerations only.

Basics of solid state lamps – white light generation techniques – Power LEDs – LED driver considerations, Daylight – Artificial light integration, lighting control strategies – Energy Management strategies – Switching Control – sensor technology – Applications, Digital lighting control based system– lighting Automation – DMX, DALI,

Unit 4

Green buildings: Specialties and benefits, target areas of a Green building design –BEE in building energy conservation in India - ECBC - Green building rating systems such as LEED and GRIHA – brief overview only.

References:

1. M. S. Sodha, N. K. Bansal, P. K. Bansal, A. Kumar and M.A.S. Malik, Solar Passive Building, Science and Design, Pergamon Press, 1986.
2. Energy Management Guide Books, Revision – II, Bureau of Energy Efficiency, India.
3. A.K Mittal, Electrical and Mechanical Services in High Rise Buildings – Design and Estimation Manual , CBS Publishers and Distributors Pvt. Ltd, New Delhi, 2014.

CO-PO Mapping Matrix for Course MTech/EE/OEC4												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	2	-	2	1	1	1	2	1	1
CO2	2	3	1	-	2	-	-	2	1	1	-	1
CO3	1	3	1	3	-	1	-	1	1	-	1	-
CO4	2	1	1	-	2	-	1	1	2	1	-	2
CO5	3	2	1	-	-	1	1	2	2	1	2	-

Dissertation Part-I (MTech/EE/3/SEC1)							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Skill Enhancement	04	08	Dissertation work	-	100	-	Viva Voce

Course Outcomes (CO)	
CO1	Ability to synthesize knowledge and skills previously gained and applied to an in depth study and execution of new technical problem.
CO2	Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
CO3	Ability to present the findings of their technical solution in a written report.
CO4	Presenting the work in International/ National conference or reputed journals.

Dissertation Part-II (MTech/EE/4/SEC2)							
Course Type	Course Credit	Contact Hours/Week	Delivery Mode	Maximum Marks		Exam Duration	Assessment Methods
				External	Internal		
Skill Enhancement	16	32	Dissertation Work	-	400	-	Viva Voce

Course Outcomes (CO)	
CO1	Ability to synthesize knowledge and skills previously gained and applied to an in depth study and execution of new technical problem.
CO2	Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
CO3	Ability to present the findings of their technical solution in a written report.
CO4	Presenting the work in International/ National conference or reputed journals.

Syllabus Contents:

The dissertation / project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The dissertation should have the following:

Relevance to social needs of society
Relevance to value addition to existing facilities in the institute
Relevance to industry need
Problems of national importance
Research and development in various domain

The student should complete the following:

Literature survey Problem Definition
Motivation for study and Objectives
Preliminary design / feasibility / modular approaches
Implementation and Verification
Report and presentation

The dissertation part- II is based on a report prepared by the students on dissertation allotted to them. It may be based on:

Experimental verification / Proof of concept.
The viva-voce examination will be based on the above report and work.

Guidelines for Dissertation Part – I and Dissertation Part - II

As per the AICTE directives, the dissertation is a yearlong activity, to be carried out and evaluated in two parts i.e. Part– I: July to December and Part– II: January to June.

The dissertation may be carried out preferably in-house i.e. department's laboratories and centers OR in industry allotted through department's T & P coordinator.

After multiple interactions with guide and based on comprehensive literature survey, the student shall identify the domain and define dissertation objectives.

The referred literature should preferably include IEEE/IET/IETE/Springer/Science Direct/ACM journals in the areas of Computing Engineering and any other related domain. In case of Industry sponsored projects, the relevant application notes, white papers, product catalogues should be referred and reported.

Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and phase wise work distribution, and submit the proposal within a month from the date of registration.

Part–I deliverables: A document report comprising of summary of literature survey, detailed objectives, project specifications, paper, proof of concept/functionality, part results, and record of continuous progress.

Part–I evaluation: A committee comprising of guides of respective specialization shall assess the progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may recommend repeating the Part-I work.

During Part– II, student is expected to exert on design, development and testing of the proposed work as per the schedule. Accomplished results/contributions/innovations should be published in terms of research papers in reputed journals and reviewed focused conferences OR IP/Patents.

Part–II deliverables: A dissertation report as per the specified format, developed system in the form of hardware and/or software, and record of continuous progress.

Part-II evaluation: Guide along with appointed external examiner shall assess the progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may recommend for extension or repeating the Part-I work.