Programme Structure

Department of Electrical Electronics & Communication Engineering

M.Tech in Electrical & Electronics Engineering

Programme Code: SET0407

Batch: 2023-2025

SHARDA UNIVERSITY

Sharda School of Engineering & Technology

Programme / Branch: M. Tech. /EEE **Batch: 2023-2025** **Term.:I**

S. No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits
				L	T	P	
THEORY SUBJECTS							
1	MIA139		MEMS, Smart Sensors and Wireless Sensor Networks	3	1	0	4
2	MIC104		Optimization Techniques in Engineering	3	1	0	4
3	MRM001		Research Methodology	1	0	0	1
4			Departmental Elective-1	3	0	0	3
5			Departmental Elective-2	3	0	0	3
6			Departmental Elective-3	3	0	0	3
7	RBL001		RBL-1	-	-	-	0
PRACTICAL SUBJECTS							
8	MEP139		MEMS, Smart Sensors and Wireless Sensor Networks Lab	0	0	2	1
9			Departmental Elective-1Lab	0	0	2	1
10	MRM001		Research Methodology	0	0	2	1
						TOTAL	**21**

SHARDA UNIVERSITY

Sharda School of Engineering & Technology

Programme / Branch: M. Tech. /EEE **Batch: 2023-2025** **Term.:II**

S. No.	Subject Code	Subjects	Teaching Load L	T	P	Credits
THEORY SUBJECTS						
1	MIA120	Industrial Automation using PLC and SCADA	3	1	0	4
2	MPS129	Distribution Generation Technologies	3	0	0	3
3		Departmental Elective-4	3	0	0	3
4		Departmental Elective-5	2	0	0	2
5		Departmental Elective-6	3	0	0	3
6		Departmental Elective-7	3	0	0	3
7	RBL002	RBL-2	-	-	-	0
PRACTICAL SUBJECTS						
8	CCU101	Community Connect	0	0	4	2
9	MIA154	PLC and SCADA Lab	0	0	2	1
10		Departmental Elective-4 Lab	0	0	2	1
11		Departmental Elective-5 Lab	0	0	2	1
TOTAL CREDITS						**23**

SHARDA UNIVERSITY

Sahrda School of Engineering & Technology

Programme / Branch: M. Tech. /EEE **Batch: 2023-2025** **Term.:III**

S. No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits
				L	T	P	
THEORY SUBJECTS							
1	MEE694		Seminar	0	0	4	2
2	MEE695		Dissertation-I	0	0	20	10
						TOTAL	**12**

SHARDA UNIVERSITY

Shrda School of Engineering & Technology

Programme / Branch: M. Tech. /EEE   Batch: 2023-2025   Term.:IV

S. No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits
				L	T	P	
THEORY SUBJECTS							
1	EEE810		Dissertation-II	0	0	32	16
						TOTAL	**16**

M.Tech in Electrical & Electronics Engineering

COURSE STRUCTURE

Department of Electrical and Electronics Engineering M.TECH in Electrical & ElectronicsEngineering															
Course Structure for batches admitted in session and onwards															
Semester	**Courses**									**Courses**	**Labs**	**L**	**T**	**P**	**Weekly Contact**	**Credits**
I	MEMS Smart Sensors and Wireless Sensor Netwworks (3-1-2) 5	Optimization Techniques in Engineering (3-1-0) 4	Research Methodology(1-0-2)	Elective 1 (3-0-2) 4	Elective 2 (3-0-0) 3	Elective 3 (3-0-0) 3	RBL-1(0-0-0)0		6	3	16	2	6	24	21
II	Industry Automations using PLC and SCADA(3-1-2) 5	Distribution Generation Technologies(3-0-0)3	Elective 4 (3-0-2) 4	Elective5 (2-0-2)3	Elective 6 (3-0-0) 3	Elective 7 (3-0-0) 3	RBL-2(0-0-0)0	Community Connect(0-0-4) 2	6	4	17	1	10	28	23
III	Seminar (0-0-4) 2	Dissertation -1 (0-0-20) 10							0	2	0	0	24	24	12
I V	Dissertation -II (0-0-32) 16								0	1	0	0	32	32	16
TOTAL CREDITS															**72**

List Of Electives

	With Specialization in **Power Systems**	With Specializationin **Instrumentation and Control**	With Specialization in**Industrial Automation**
1	Extra High Voltage Transmission	Advanced Control Engineering And Controllers	Advanced Control Engineering And Controllers
2	Modeling & Analysis Of Power System	Smart Power Grid And Micro grid	Smart Power Grid And Micro grid
3	Power Systems Operation& Control	Optimal Control	Electrical Drives
4	Power System Reliability Assessment	Intelligent Actuators And Mechatronics	Intelligent Actuators And Mechatronics
5	Smart Power Grid And Micro grid	Virtual Instrumentation	Virtual Instrumentation
6	FACTS Devices And Systems	Analog And Digital Signal Processing	Digital Signal Processing Techniques
7	Digital Relaying For Power Systems	Industrial Network Protocols And IoT	Industrial Network Protocols And IoT
8	Power Quality	Industrial Robotics	Industrial Robotics
9	Wind And Solar Energy Systems	Embedded Systems	Embedded Systems
10	Wireless Sensor Networks And Application	Industrial Instrumentation	Mechatronics of Robotics
11	Sustainable Energy	Analog And Digital Communication Techniques	Wind And Solar Energy Systems
12	Electrical And Hybrid Vehicles	Sustainable Energy	Electrical And Hybrid Vehicles
13	Operation and control of smart grid	Electrical And Hybrid Vehicles	Internet of Things and Applications
14	Restructured Power System	Biomedical Instrumentation	Optimal Control
15	Internet of Things and Applications	Internet of Things and Applications	

Course Module
Term-I

School: SSET		**Batch : 2023-25**
Programme: M.Tech		**Current Academic Year: 2023-24**
Branch: EEE		**Semester: 1**
1	Course Code	MIA139
2	Course Title	MEMS, Smart Sensors and Wireless Sensor Networks
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	To provide students with: 1. basic principles and techniques of MEMS and Smart Sensors 2. knowledge of various fabrication and machining process of MEMS along with its benefits in relation to applications 3. Knowledge in wireless sensor networks and to apply this knowledge in various industrial application like environmental monitoring, structural health and greenhouse monitoring
6	Course Outcomes	After completion of this course the students will be able to CO1: To be able to understand architecture of smart sensors along with differences among smart, intelligent and network sensors. CO2: To be familiar with the important concepts MEMS and smart sensor fabrication technologies. CO3: To be able to select and use the MEMS based sensors for different applications. CO4To be able to select and use smart sensors for different applications. CO5: To understand principles of wireless sensor networks and differentiate among various wireless network protocols . CO6: To apply and develop WSN based real time applications of WSN in various industrial, environmental and societal domains.
7	Course Description	This course is aimed at equipping students with basic knowledge on of MEMS (Micro electro Mechanical System), Smart sensor and its various fabrication techniques. This course also enables the student with appropriate knowledge of Wireless sensor network and its applications in industry.

8	Outline syllabus		CO Mapping
	Unit 1	**Basics of MEMS and Smart Sensors**	
	A	Overview of measurement system, transducers, Sensors : Types, open and closed loop control system , actuators in open and closed loop and signal conditioners	CO1
	B	Definition and working principle of MEMS-Based Acceleration Sensor, MEMS-Based Pressure Sensor, MEMS-Based Micro-Motor (Actuator), MEMS-Based Resonator (Sensor/Actuator), Smart MEMS Sensors with	CO1

		Analog/Digital Output, Smart MEMS Sensors with Quasi-Digital Output	
	C	Definition and architecture of smart sensor; different levels of integration in smart sensors; Differences between smart, intelligent and network sensors; Advantages of smart sensors, Smart MEMS Devices,	CO1
	Unit 2	**MEMS and Smart Sensor Technologies**	
	A	Micro-machining processes: materials for micro-machining, wafer bonding, bulk and surface micromachining	CO2
	B	IC Technologies: thick film, thin film technologies	CO2
	C	Monolithic IC technology	CO2
	Unit 3	**Case studies of MEMS and Smart Sensors**	
	A	Principles, characteristics and constructional details of MEMS-based smart acceleration and pressure sensor, MEMS-Based Micro-Motor (Actuator), MEMS-Based Resonator (Sensor/Actuator), Smart MEMS Sensors with Analog/Digital Output, Smart MEMS Sensors with Quasi-Digital Output	CO3
	B	Principle, characteristics and constructional details of a smart temperature sensor	CO4
	C	Principle, characteristics and constructional details of a smart humidity sensor	CO4
	Unit 4	**Wireless Sensor Network**	
	A	WSN-Based Monitoring System, Need and advantages of WSN, Network topologies; seven-layer OSI model of communication system	CO5
	B	Zgbee (IEEE – 802.15.4) protocol, Merits of Zigbee over Wi-Fi (IEEE – 802.11) and Bluetooth for WSN, Architecture of Wireless sensor node	CO5
	C	Sensor and actuator network (SAN) - homogeneous and heterogeneous SAN and comparison	CO5
	Unit 5	**Wireless Sensor Network based Applications**	
	A	Spectrum of applications; Case studies on WSN application: Environment monitoring, Forest fire detection	CO6
	B	Condition monitoring - Structural health , Equipment health monitoring, PV module monitoring	CO6
	C	Greenhouse monitoring and control, Human health monitoring	CO6
	Mode of examination	Theory	

	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	

	Text book/s*	1 D. Patranabis, "Sensors and Transducers", Prentice-Holl, 2nd Edition, 2003. 2 Randy Frank, "Understanding Smart Sensors", Artech House, 2nd Edition, 2000. 3 E.H. Callaway, "Wireless Sensor Networks : Architecture and Protocols"	
	Other References	1. H.K. Verma, e-monograph on "Smart Sensors", at www.profhkverma.info, Chapter 1 – Basics of Smart Sensor, Chapter 2 – Smart Sensor Technologies, Chapter 3 – Case Studies of Smart Sensors. 2. H.K. Verma, e-monograph on "WSN", at www.profhkverma.info, Chapter 1 – Wireless Sensor Network, Chapter 2 – Wireless Sensor Node, Chapter 3 – Applications of Wireless Sensor Networks.	

School: SSET		Batch : 2023-25
Programme: M.Tech		**Current Academic Year: 2023-24**
Branch: EEE		**Semester: 1**
1	Course Code	MIC104
2	Course Title	Optimization Techniques in Engineering
3	Credits	4
4	Contact Hours (L-T-P)	3-1-0
	Course Status	Compulsory
5	Course Objective	This course provides the students with: 1. Knowledge of solving linear and nonlinear Algebraic equations 2. Knowledge of solving differential equations 3. Introduction to various concepts of Optimization Techniques. 4. Awareness to the importance of optimizations in real scenarios; 5. Knowledge of various classical and modern methods of constrained and unconstrained problems in both single and multivariable. 6. Knowledge of Various Evolutionary Techniques 7. Ideas to solve Integer programming.
6	Course Outcomes	After completion of this course the students will be able to CO1: Solve various linear and nonlinear Algebraic equations CO2: Solve various Differential equations CO3: Formulate optimization problems CO4: Apply the concept of optimality criteria for various type ofoptimization problems and solve various constrained and unconstrained problems CO5: Know various Evolutionary Techniques and Solve integer Programming problems. CO6: Apply Optimization Techniques in real time applications.
7	Course Description	Optimization is the process of obtaining the best result under given circumstances. In design, construction and maintenance of any engineering system, engineers have to take many technological and managerial decisions at several stages. The ultimate goal of all such decisions is either to minimize the effort required or to maximize the desired benefit. A number of optimization methods have been developed for solving different types of optimization problems.
8	Outline syllabus	CO Mapping

	Unit 1	**Algebraic Equations**

	A	Introduction of Algebraic Equations. Iterative methods for solving non linear equations-Bisection method, Regulafalsi method, Newton Raphson method, secant method.		CO1
	B	Fixed Point method, Two equation Newton Raphson method.		CO1
	C	Iterative methods for solving linear equations-Jacobi method, Gauss- seidel method		CO1
	Unit 2	**Differential Equations**		
	A	Finite difference method		CO2
	B	Euler"s method		CO2
	C	Runga-kutta methods(fourth order)		CO2
	Unit 3	**Optimization Problems**		
	A	Requirements for the optimization methods, Types of optimization problem		CO3
	B	Feasible solution and feasible region, Necessary and sufficientoptimality conditions, Graphical method for optimal solution.		CO3
	C	Simplex method and Dual Simplex method		CO3,CO6
	Unit 4	**Optimization Techniques**		
	A	Lagrange multiplier, Kuhn-tucker conditions		CO4,CO6
	B	Newtons method,Interior Penalty function method,		CO4,CO6
	C	Rosen Gradient projection method		CO4,CO6
	Unit 5	**Evolutionary Techniques and Integer Programming**		
	A	Genetic Algorithm, Particle swarm and ant colony optimization methods		CO5,CO6
	B	Branch and Bound method		CO5,CO6
	C	cutting plane method		CO5,CO6
	Mode of examination	Theory		
	Weightage Distribution	CA	MTE	ETE
		25%	25%	50%
	Text book/s*	1 Balagurusamy, E., "Numerical methods", Tata McGrawHill 2 Rao S.S, "Engineering Optimization: Theory andPractice", wiley		

School: SSET		**Batch: 2023-2025**	
Programme: M Tech		**Current Academic Year: 2023-24**	
Branch: EEE		**Semester: I**	
1	Course Code	MEP 139	
2	Course Title	MEMS, Smart Sensors and Wireless Sensors Network Lab	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	Compulsory	
5	Course Objective	To provide students with: 1. To equip students with the working knowledge about the smart sensors and their interfacing with microcontrollers. 2. To provide practical knowledge about WS nodes and WSN configuration. 3. To provide the knowledge for analyzing the profile measurement of various parameters.	
6	Course Outcomes	After completion of this course the students will be able to CO1: To understand basics of Smart Sensors. CO2: To interface and measure various parameters using smart sensors with microcontrollers /DAQ cards. CO3: To interface and measure various parameters using smart MEMS based sensors with microcontroller/ DAQ cards CO4: To understand fundamentals of Wireless sensor networks CO5: To configure WS node and build a wireless network. CO6: To acquire and control the parameter data from the WSN and analyze the temporal and spatial profiling	
7	Course Description	The contents of this course cover the measurement of temperature using the smart sensors with different type of outputs. Also, the interfacing of smart sensors with the microcontroller has been focused. Data acquisition with DAQ cards is also covered in this course. Configuring WS nodes, building WSN and profile measurement have been are also a part of it.	
8	Outline syllabus		CO Mapping
	Unit 1	**Interfacing of smart sensors**	
	A	Measurement of Temperature with Smart temperature Sensor AD592 with analog current output.	CO1
	B	Measurement of Temperature with Smart temperature Sensor LM 35 with analog voltage output	CO1
	C	Measurement of soil moisture using appropriate sensor	CO1
	Unit 2	**Interfacing of Smart MEMS**	

	A	Interfacing of Smart humidity and temperature sensor output (SHT75) with digital serial output.			CO2
	B	Interfacing of Smart MEMS acceleration sensor to microcontroller/DAQ.			CO2
	C	Interfacing of Smart MEMS pressure sensor to microcontroller/DAQ Card			CO2
	Unit 3	**Configuring a wireless sensor network using TL Sensor Node (SENSEnuts)**			
	A	Installing the toolchain			CO3
	B	Configuring TL node as sensing node and as broadcasting node			CO3
	C	Create a GUI for data acquisition			CO3
	Unit 4	**Configuring a wireless sensor network using HTP Sensor Node (SENSEnuts)**			
	A	Configuring HTP node as sensing node			CO4
	B	Configuring HTP node as broadcasting mode			
	C	Create a GUI for data acquisition			CO4
	Unit 5	**Profiling of parameters**			CO4
	A	Setting up Wireless sensor Network			CO5
	B	Temporal profiling of a parameters for TL sensor network			CO5,CO6
	C	Temporal profiling of a parameters for HTP sensor network			CO5,CO6
	Mode of examination	Practical & Viva			
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	
	Text book/s*	1. D. Patranabis, "Sensors and Transducers", Prentice-Holl, 2nd Edition, 2003. 2. Randy Frank, "Understanding Smart Sensors", Artech House, 2nd Edition, 2000. 3. E.H. Callaway, "Wireless Sensor Networks : Architecture and Protocols" 4. Manuals of various sensors provided by the manufacturers. 5. Lab Manuals			
	Other References	1. H.K. Verma, e-monograph on "Smart Sensors", at www.profhkverma.info, Chapter 1 – Basics of Smart Sensor, Chapter 2 – Smart Sensor Technologies, Chapter 3 – Case Studies of Smart Sensors.			

		2. H.K. Verma, e-monograph on “WSN”, at www.profhkverma.info, Chapter 1 – Wireless Sensor Network, Chapter 2 – Wireless Sensor Node, Chapter 3 – Applications of Wireless Sensor Networks.	

School: SSET		Batch : 2023- 2025	
Programme: M.Tech		**Current Academic Year: 2023-2024**	
Branch: EEE		**Semester: I**	
1	Course Code	RBL001	
2	Course Title	Research Based Learning -1	
3	Credits	0	
4	Contact Hours (L-T-P)	0-0-0	
	Course Status	Compulsory	
5	Course Objective	To provide students with: 1To align student's skill and interests with a realistic problem or project 2.To understand the significance of problem and its scope 3. Students will make decisions within a framework	
6	Course Outcomes	After the completion of course student will be able to CO1: Literature Survey in Identified stream. CO2:Identifying the research gaps. CO3: Learn appropriate simulation software / experimental set up. CO4: Comparative Study. CO5: Draft a review article. CO6: Communicating the article.	
7	Course Description	In RBL-1, the students will learn how to define the problem for developing projects, identifying the skills required for developing the project based on given a set of specifications and all subjects of that Semester.	
8	Outline syllabus		CO Mapping
	Unit 1	Study research papers.	CO1, CO2
	Unit 2	Identify the research area.	CO2,CO3
	Unit 3	Learn the simulation software.	CO3
	Unit 4	Comparative study related to identified research area.	CO3, CO4
	Unit 5	Prepare a write up based on comparative study and communicate the article.	CO4, CO5, CO6

	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	

School: SSET		Batch : 2023-2025	
Programme:M.Tech		**Current Academic Year: 2023-24**	
Branch: EEE		**Semester: I**	
1	Course Code	MRM001	
2	Course Title	Research Methodology	
3	Credits	2	
4	Contact Hours (L-T-P)	1-0-2	
	Course Status	Compulsory	
5	Course Objective	• To develop understanding of the basic framework of research process. • To develop an understanding of various research designs and techniques. • To identify various sources of information for literature review and data collection. • To develop an understanding of the ethical dimensions of conducting applied research. • Appreciate the components of scholarly writing and evaluate its quality.	
6	Course Outcomes	CO1: Infer the mind-set of a researcher CO2: Design a research plan CO3: Apply different methods for data collection CO4: Analyse the collected data CO5: Compile relevant data and prepare a report CO6: Infer the process of research right from inception of idea to execution and documentation.	
7	Course Description	The course aims to develop a research orientation among the scholars and to acquaint them with fundamentals of research methods. Specifically, the course aims at introducing them to the basic concepts used in research and to scientific social research methods and their approach. It includes discussions on sampling techniques, research designs and techniques of analysis.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Introduction to research – The role of research, research process overview	CO1

	B	Philosophies and the language of research theory building – Science and its functions, What is theory?, and The meaning of methodology	CO1,CO2
	C	Thinking like a researcher – Understanding Concepts, Constructs, Variables, and Definitions	CO1,CO2
	Unit 2	**Research Problem and Hypotheses**	
	A	Defining the research problem, The importance of problems	CO2,CO3
	B	Formulation of the research hypotheses, The importance of hypothesis	CO2,CO3
	C	Experimental and Non-experimental research design	CO2,CO3
	Unit 3	**Data Collection**	
	A	Field research, and Survey research	CO4,CO5
	B	Methods of data collection– Secondary data collection methods	CO4,CO5
	C	Methods of data collection– qualitative methods of data collection, and Survey methods of data collection	CO4,CO5
	Unit 4	**Data Analysis**	
	A	Attitude measurement and scaling – Types of measurement scales; Questionnaire designing – Reliability and Validity	CO5,CO6
	B	Sampling techniques – The nature of sampling, Probability sampling design, Non-probability sampling design, Determination of sample	CO5,CO6
	C	Processing and analysis of data	CO5,CO6
	Unit 5	**Report Writing**	
	A	Ethical issues in conducting research	CO6
	B	Report generation and report writing	CO6
	C	APA format – Title page, Abstract, Introduction, Methodology, Results, Discussion, References, and Appendices	CO6

	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	

	Text book/s*	• Chawla, Deepak & Sondhi, Neena (2011). Research methodology: Concepts and cases, Vikas Publishing House Pvt. Ltd. Delhi • Bryman, Alan & Bell, Emma (2011). Business Research Methods (Third Edition), Oxford University Press.	

	Other References	• Kerlinger, F.N., & Lee, H.B. (2000). Foundations of Behavioural Research (Fourth Edition), Harcourt Inc. • Rubin, Allen & Babbie, Earl (2009). Essential Research Methods for Social Work, Cengage Learning Inc., USA.	

Course Module
Term-II

School: SSET		**Batch : 2023-25**	
Programme: M.Tech		**Current Academic Year: 2023-24**	
Branch: EEE		**Semester: II**	
1	Course Code	MIA120	
2	Course Title	Industrial Automation using PLC and SCADA	
3	Credits	4	
4	Contact Hours (L-T-P)	3-1-0	
	Course Status	Compulsory /Elective/Open Elective	
5	Course Objective	To provide students with: 1.The conceptual as well as practical knowledge of the Industrial Automation & latest technologies being used to achieve Industrial Automation.	
6	Course Outcomes	After completion of this course students will be able to: CO1: Describe working of various blocks of basic Industrial Field Instrumentation & Controllers CO2: To provide knowledge levels needed for PLC Programming and operating. CO3: Connect the peripherals with the PLC. CO4: Use various PLC functions and develop small PLC Programmes. CO5: Getting knowledge of PLC SCADA applications in different industries. CO6: Getting knowledge about different types communication in the automation field.	
7	Course Description	This course is aimed at equipping students with appropriate knowledge and skills required in configuring, Programming and operating Industrial automation systems with the use of Industrial Field Instruments, PLCs, SCADA/ HMI and DCS.	
8	Outline syllabus		CO Mapping
	Unit 1	**Industrial Field Instrumentation & Controllers**	
	A	Microprocessor/microcontroller based industrial controller: concept and configuration	CO1
	B	Industrial Automation System structure, functional levels and instrumentation signal levels	CO1
	C	Industrial Control Valves, Signal conditioners, and intelligent transmitters	CO1
	Unit 2	**PLC Basics**	
	A	Introduction to PLC, PLC versus microprocessor/microcontroller/computer; Advantages and disadvantages of PLC	CO2
	B	Hardware, internal architecture and physical forms of PLC; Digital inputs/ outputs; Analog inputs/ outputs	CO3

	C	PLC Programming: ladder Programming, function blocks, Instruction lists, Sequential function chart, mnemonic Programming	CO2, CO6
	Unit 3	**PLC Functions**	
	A	Registers: holding, input and output registers; Timers and timer functions; Counters and counter functions.	CO4
	B	Data handling functions; Bit functions; Analog Input/ Output Cards and control loops	CO4
	C	Advanced functions; PLC Programming using various functions; Structured Programming (Functions & Function blocks)	CO4, CO6
	Unit 4	**SCADA Basics, Layout and Functions**	
	A	Introduction; Definition and purpose; Controlled / uncontrolled variables and remotely / locally controlled objects in controlled plant	CO5
	B	Layout and parts of SCADA system; Detailed block schematic of SCADA system	CO5
	C	Functions of SCADA system: data acquisition and transmission, monitoring, control, data collection and storage, data processing and calculation, report generation	CO5
	Unit 5	**SCADA Hardware and Software**	
	A	Master Terminal Unit (MTU): functions, single processor and multiprocessor MTU, single and dual computer configurations of MTU	CO5
	B	Remote Terminal Unit (RTU): functions, architecture / layout; RTU Programming; MTU-RTU communication and RTU-field device communication	CO5, CO6
	C	OPC Server (OLE for Process Control)/PLC (RTU) and SCADA Interface Configuration concepts	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25% · MTE: 25% · ETE: 50%	
	Text book/s*	1. J.W. Webb and R.A. Reis, Programme able Logic Controllers, Prentice-Hall India 2. . Stuart A. Boyer, Supervisory Control and Data Acquisition (SCADA), 4th Edition, International Society of Automation, 2010.	
	Other References	J.R. Hackworth and F.D. Hackworth, Programme able Logic Controllers, Pearson Edition 2. W. Boston, Programme able Logic Controllers, Newnes,(Elsevier). 3. H.K. Verma, SCADA, e-monograph at www.profhkverma.info, Chapter 1: Basics of SCADA,	

		Chapter 2: Functions of SCADA System, Chapter 3: Hardware of SCADA System.	

School: SSET		**Batch : 2023-2025**
Programme: M.Tech		**Current Academic Year: 2023-2024**
Branch: EEE		**Semester: I**
1	Course Code	MPS129
2	Course Title	Distributed Generation Technology
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Compulsory
5	Course Objective	To provide students with: 1. To introduce the concept of distributed generation, microgrids, electric vehicles and energy storage. 1. To familiarize the students with renewable generation system modelling, and their grid integration issues. 2. To impart an understanding of economics, policies and technical regulations for DG integration
6	Course Outcomes	After completion of this course students will be able to: CO1 : Analyse the concept and importance of distributed generation and micro grid. CO2: Understand different renewable energy-based DG sources and other alternate DG sources. CO3: Evaluate the technical impact of DG in power system CO4: Analyse power quality issues with DG and reactive power control. CO5: Evaluate the effect of DG placement in the existing system. CO6: Understand different types of grid interfaces and storage devices
7	Course Description	This syllabus gives an overview of distributed energy resources, photovoltaic systems, small hydro, fuel cells, energy storage technologies; wind turbines, Principles of control of distributed generation systems; Electric power distribution systems, installation, interconnection and integration; Economic and financial aspects of distributed generation, the regulatory environment and standards.

8	**Outline syllabus**		CO Mapping
	Unit 1	**Introduction to Distributed Generation**	CO1
	A	Concept of DG and, its definition, Current scenario in distributed generation	CO1
	B	Need for distributed generation	CO1
	C	Advantage and limitation of DG	CO1
	Unit 2	**Renewable based Distributed generation**	
	A	Wind power plant	CO2

	B	Solar power plant			CO2
	C	Small hydro other alternate DG			CO2
	Unit 3	**Technical impacts of DG**			CO3
	A	Transmission systems, Distribution systems			CO3
	B	Impact of DGs upon protective relaying			CO3
	C	Impact of DGs upon transient and dynamic stability of existing distribution systems			CO3
	Unit 4	**Operation and Economic aspects of DGs**			CO4
	A	De-regulation of power system			CO4
	B	Voltage control techniques, Reactive power control, Harmonics, Power quality issues, Reliability of DG based systems			CO4
	C	Economic impacts: Market facts, issues and challenges			CO4
	Unit 5	**Grid integration of DGs**			CO5
	A	Optimal placement of DG sources in distribution systems			CO5
	B	Different types of interfaces, Inverter based DGs and rotating machine-based interfaces, Aggregation of multiple DG units			CO5
	C	Energy storage elements, Batteries, ultra capacitors, flywheels			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1. Renewable Energy- Power for a sustainable future, third edition, Edited by Godfrey Boyle, Oxford University Press, 2013.			
	Other References	1. Microgrids and Active Distribution Networks, S. Chowdhury, S.P. Chowdhury and P. Crossley, The Institution of Engineering and Technology, London, U.K, 2009			

School: SSET		Batch : 2023- 2025		
Programme: M.Tech		**Current Academic Year: 2023-2024**		
Branch: EEE		**Semester: II**		
1	Course Code	RBL002		
2	Course Title	Research Based Learning -2		
3	Credits	0		
4	Contact Hours (L-T-P)	0-0-0		
	Course Status	Compulsory		
5	Course Objective	1.To provide students with: 1. To align student's skill and interests with a realistic problem or project 2. To understand the significance of problem and its scope 3. Students will make decisions within a framework		
6	Course Outcomes	After the completion of course student will be able to CO1: Literature Survey in Identified stream. CO2: Identifying the research gaps. CO3: Learn appropriate simulation software / experimental set up. CO4: Comparative Study. CO5: Draft a research article. CO6: Communicating the article.		
7	Course Description	In RBL-2, the students will learn how to define the problem for developing projects, identifying the skills required for developing the project based on given a set of specifications and all subjects of that Semester.		

					CO Mapping
8	Outline syllabus				CO Mapping
	Unit 1	Study research papers.			CO1, CO2
	Unit 2	Formulate the research problem.			CO2,CO3
	Unit 3	Apply the simulation software to the identified research problem.			CO3
	Unit 4	Analysis of the results obtained from simulation.			CO3, CO4
	Unit 5	Prepare a write up based on identified research work and communicate the article.			CO4, CO5, CO6
	Mode of Examination	Practical			
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	

School: SSET		Batch : 2022-24
Programme: M.Tech		**Current Academic Year: 2022-23**
Branch:EEE		**Semester: 1**
1	Course Code	CCU101
2	Course Title	Community Connect
3	Credits	2
4	Contact Hours (L-T-P)	(0-0-2)
	Course Status	Compulsory
5	Course Objective	To provide students with: 1. To connect the students to the community. 2. To conduct survey of community people and record responses and identify the issues faced by the community. 3. To do detailed analysis of data collected in the survey and student will use their learning to propose suitable solution for these issues. 4. To enhance skills of students on communication, data analysis and report writing skills. 5.To conduct survey on general awareness.
6	Course Outcomes	After completion of this course the students will be able to CO1. Interpret knowledge on different issues faced by the community in better way. CO2. Analyze data and identify problems CO3. Solve the complex problems efficiently CO4. Construct documentation, data analysis and report on any project. CO5. Estimate the engineering and societal values of the developed solution for the problem CO6. Utilize technology-based knowledge to improvise the existing solution for the problem
7	Theme	Major Sub-themes for research: 1. Energy solutions, saving and management 2. Electronics solution in everyday life 3. Civil works like transportation, drainage, water, construction etc. 4. Agriculture and irrigation, crop production 5. IoT and smart solutions 6. Medical and Healthcare issues 7. Environmental issues 8. Security and surveillance 9. Education and skills
8.1	**Guidelines for Faculty Members**	● Any one of the sub-themes can be taken as survey topics ● It will be a group assignment. ● There should be no more than 10 students in each group.

		● The faculty guide will guide the students to complete the survey and help the student in preparing final report. ● The questionnaire should be well design by the school and it should carry at least 40 questions (Including demographic questions). ● The faculty will guide each group of students to prepare the PPT. ● Each group should submit the report to CCC-Coordinator signed by the faculty guide before one week of last date of instruction mentioned in the Academic Calendar. The students have to send the hard copy of the report and PPT, and then only they will be allowed for ETE.
8.2	**Role of CCC-Coordinator**	● The CCC Coordinator will supervise the whole process and assign students to faculty members.
8.3	**Layout of the Report**	Abstract (250 words) ● Introduction ● Literature review(optional) ● Objective of the research ● Research Methodology ● Questionnaire ● Expected Outcomes ● References Note: Research report should base on primary data
8.4	**Guideline for Report Writing**	**Title Page: The following elements must be included:** ● Title of the article; ● Name(s) and initial(s) of author(s), preferably with first names spelled out; ● Affiliation(s) of author(s); ● Name of the faculty guide and Co-guide **Abstract:** Each article is to be preceded by a succinct abstract, of up to 250 words, that highlights the objectives, methods, results, and conclusions of the paper. **Text: Manuscripts should be submitted in Word.** ● Use a normal, plain font (e.g., 12-point Times Roman) for text. ● Use italics for emphasis. ● *Use the automatic page numbering function to number the pages.* ● *Save your file in docx format* (Word 2007 or higher) or doc format (older Word versions) **Reference list:** The list of references should only include works that are cited in the text and that have been published or accepted for publication. The soft copy of final report should be submitted along with the **hard copy signed by faculty / guide and countersigned by HoD / Dean.**

		• **The report will be subject to plagiarism check as per the guidelines given in the notification.**
8.5	**Format**	**The report should be Spiral / softbound** Cover page Acknowledgement Content Project report Appendices
8.6	**<u>Important Dates:</u>**	Students will complete their community survey before last instruction date of the running semester and submit the same to concern faculty member. (Each group should complete min 50 questionnaires). Faculty members should guide students for report writing. The students should submit the hard copy and soft copy of the report to CCC-Coordinator signed by the faculty guide. The students should submit the soft copy of the PPT to CCC-Coordinator signed by the faculty guide before 1 week of final presentation. The final presentation and evaluation should be organised by the School before last instruction date.
8.7	**<u>ETE</u>**	The students will be evaluated by panel of internal faculty members on the basis of their presentation.
	Mode of examination	Practical/Viva

	Weightage Distribution	CA	CE	ETE
		25%	25%	50%

Programme Electives

School: SSET		**Batch: 2023-2025**
Programme: M Tech		**Current Academic Year: 2023-24**
Branch: EEE		**Semester: I**
1	Course Code	MIA113
2	Course Title	Intelligent Actuators and Mechatronics
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Department Elective
5	Course Objective	To provide students with: 1. Discussing of basic components of actuators and mechatronics 2. Discussing of electronics and digital circuits concepts of the subject 3. Explaining concept of intelligent and smart system 4. Discussing of interfacing concepts of mechatronics systems 5. Giving case studies and exploring knowledge on designing
6	Course Outcomes	After completion of this course the students will be able to CO1: Getting knowledge on basic components of actuators and mechatronics CO 2: Exploring knowledge and getting design concepts of circuits CO 3: Identifying concepts smart and intelligent on mechatronics systems CO 4: Able to design of interfacing circuits for the subject CO 5: Able to design of tailor-made systems CO6: Develop a simulation model for simple physical systems and explain mechatronics design process
7	Course Description	The field of mechatronics has broadened the scope of the traditional fieldof electromechanics. The subject is made to know modern trends on mechatronics system, hybrid of different engineering, stand alone mechatronics systems.
8	Outline syllabus	
	Unit 1	**Introduction**
	A	Definitions: Mechatronics & actuator; Overview of sensors, current & voltage sources; Grounding
	B	Solenoids, relays, electrical motors for actuators
	C	Basics of open loop and closed loop systems , block diagram of mechatronics system ; Scope of the course
	Unit 2	**Overview of Analog and Digital Electronics**
	A	Active electronic devices for mechatroics, basics of operation amplifiers and instrumentation amplifiers
	B	Display systems, measurement systems, testing and calibration
	C	Combination logic and logic classes; Flip-flops and their applications; Microcontroller concepts

	Unit 3	**Smart and Intelligent Actuators**
	A	Definitions: Smart and intelligent actuators; Architecture and
		operation of smart actuator
	B	Intelligent actuator without feedback sensor in detail
	C	Intelligent actuator with feedback sensor in detail
	Unit 4	**Mechanical-Electronic Interfacing**
	A	Concept of three-state (tri-state) outputs; Interfacing of pushbutton, keyboard and sensors
	B	Interfacing of relays, solenoids, DC, AC motors and special motors to microcontroller
	C	Selecting of motor for actuators
	Unit 5	**Case studies & Design Exercise**
	A	Case study 1: Mechatronic design of a coin counter; Case study
	B	Case study 2: Mechatronics for conveyor based material handling system
	C	Design exercise on mechatronic system
	Mode of examination	Theory
	Weightage Distribution	CA: 25% / MTE: 25% / ETE: 50%
	Text book/s*	David G, Alciatore et al., “Introduction to Mechatronics and Measurement Systems”, Tata McGraw Hill, 2003
	Other References	1. W.Bolton, “Mechatronics “, Pearson Education, 2005 2. Godfrey C. Onwubolu, “Mechatronics”, Elsevier, 2005

School: SSET		**BATCH**: 2023-25	
Programme: M.Tech		**Current Academic Year: 2023-24**	
Branch: EEE/EE		**Semester: 1**	
1	Course Code	MIA111	
2	Course Title	Advanced Control Engineering and Controllers	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Compulsory	
5	Course Objective	To provide students with: 1. some advanced concepts in Control Systems Engineering and their applications. 2.A theoretical understanding of advanced linear control systems and strategies,including the principles of digital control. 3 understanding of performing stability analysis of digital control systems. 4. knowledge of Analog controller, computer-based controller and intelligentcontroller	
6	Course Outcomes	After completion of this course students will be able to: CO1: Understand advanced concepts and approaches to control system designs. CO2: Understand industrial controllers of continuous and discontinuous typesand advanced control concepts of cascaded and feed forward controls. CO3: design, develop and operate analog controllers, both electronic andpneumatic types. CO4: Design develop and operate computer-based control systems. CO5: Understand simulate and design artificial intelligence-based control system. CO6: Understand simulate and design the advance controllers for the given plant.	
7	Course Description	This course introduces systematic approaches to the design and analysis of advance control systems for industrial applications.	
8	Outline syllabus		CO Mapping
	Unit 1	**Overview of Control System**	
	A	Elements of control systems; Concept of open loop and closed loop systems; Examples and application of open loop and closed loop systems	CO1
	B	Brief idea of multivariable control systems; Concept of stability and necessary conditions, Routh-Hurwitz criteria and limitations. Correlation between time and frequency responses	CO1

	C	State variable modelling of linear discrete systems, controllability and observability; Nonlinear control systems; Fundamentals- zone, relay, on-off nonlinearity, backlash, hysteresis common nonlinearities (saturation, dead-	CO1
	Unit 2	**Controller Principles**	
	A	Process Characteristics; Control system parameters: error,	CO2
		variable range, control parameter range, control lag, dead time, cycling	CO2
	B	Discontinuous controller modes: two-position mode, multi-position mode; Continuous controller modes	CO2
	C	proportional, integral and derivative control modes; Composite Control modes: proportional-integral (PI), proportional-derivative (PD) and three mode controller (PID); Cascaded and feed-forward controls	CO2
	Unit 3	**Analog Controllers**	
	A	Introduction; General features	CO3
	B	Electronics controllers : error detector, single mode and composite mode controller;	CO3
	C	Pneumatic controllers: proportional, proportional-integral (PI), proportional-derivative (PD) and PID controller.	CO3
	Unit 4	**Computer Based Control**	
	A	Introduction; Digital applications: alarms, two-position control	CO4
	B	Computer based controller	CO4
	C	hardware configurations, software requirements	CO4
	Unit 5	**Intelligent Control Systems**	
	A	Fuzzy-logic control system: Fuzzy set theory, basic fuzzy set operations, fuzzy relations, fuzzy logic controller, methods of determination of membership functions	CO5
	B	Methods of defuzzification, fuzzy rule base, design of fuzzy logic control system.	CO5
	C	Neural-network control system :Artificial neural networks, operation of a single artificial neuron, network architecture, learning in neural networks, back-propagation, Neuro fuzzy control	CO5
	Mode of examination	Theory	
	Weightage Distribution	CA: 25% · MTE: 25% · ETE: 50%	
	Text book/s*	1. Curtis D. Johnson "Process Control Instrumentation Technology,"8th Edition Pearson. 2. I.J. Nagrath and M. Gopal, "Control Systems Engineering,"4th Edition, New Age International Publishers.	

	Other References	1. S.N. Sivanandam and S.N. Deepa, “Principles of softcomputing,” Wiley India Pvt. Limited. 2. S.Rajashekaran and G.A. VijayalakshmiPai, “ Neural Nwtworks,Fuzzy logic, and Genetic Algorithms,” PHI Pvt.Limited.

School: SSET		**Batch: 2023-25**
Programme: M.Tech		**Current Academic Year:2023-24**
Branch: EEE		**Semester: I**
1	Course Code	MPS121
2	Course Title	Smart Power Grid and Microgrid
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	
5	Course Objective	To provide students with: 1. To understand the concepts of smart power grid and micro grid 2. To acquire in depth knowledge of smart distribution, distribution automa-tion, smart transmission and substation automation 3. To identify various components of smart grid and micro grid 4. To apply principles of automation to transmission and distribution 5. To design smart microgrid for a given application
6	Course Outcomes	After completion of this course students will be able to: CO1: To understand concept, motivation and benefits of Smart PowerGrid CO2: To develop knowledge of demand-side management as a tool of smart distribution CO3:To design advanced metering infrastructure for Distribution Automation CO4: To design AC, DC and hybrid micro grids CO5:To design phasor measurement and develop wide areaMonitoring system using PMU CO6: Industrial experiences in renewable energy integration in distribution system
7	Course Des cription	The course deals with the concept of smart power grid and includes in depth study of its its various components, namely smart distribution, distribution automation and management, advanced metering infrastructure, smart microgrid, smart transmission and substation automation.

8	Outline syllabus		CO Mapping
	Unit1	**Introduction to Smart Power Grid(4hours)**	
	A	Traditional power grid, Smart power grid (or smart grid)concept and objectives	CO1
	B	Benefits of smart power grid, traditional-grid and smart-grid comparison	CO1,CO2
	C	Stakeholders in smart-grid development, Smart gridsolutions.	CO1CO2
	Unit2	**Smart Distribution**	
	A	Demand-side management: Energy efficiency, time of use and spinning reserve	CO2,CO3
	B	Demand response: Market driven DR and operation-	CO3

		driven DR, incentive-based DR and TOU-based rates DR	
	C	Distributed generation, Energy storage, Use of plugged electric and hybrid electric vehicles	CO3
	Unit3	**Distribution Automation and Management**	
	A	Overview of distribution system, Components of DA: customer automation, feed erau to mation and substation automation, Distribution control centre(DCC)	CO3
	B	Distribution management system(DMS),Outage management system(OMS)- unplanned and planned outages, Asset management system(AMS),Customer information system(CIS)	CO3
	C	Meaning and benefits of advanced metering, Structure and components of AMI,AMI integration with DA, DMS and OMS.	CO3
	Unit4	**Smart Microgrid**	
	A	Definition, components and benefits of micro grid	CO4
	B	Types of microgrid: AC, DC and hybrid, Modes of operation: grid-connected and island modes	CO4 ,CO 6
	C	Meaning of smart micro grid, Microgrid operation andcontrol	CO4,CO6
	Unit5	**Smart Transmission and Substation Automation**	
	A	Meaning and challenges of smart transmission	CO5,CO6
	B	applications, Wide area monitoring system: concept and impact on EMS and DMS	CO5,CO6
	C	Need of substation automation (SA),Technical issues of SA,S Architecture ,SA function.	CO5,CO6

	Mode of examination	Theory		
	Weightage Distribution	CA	MTE	ETE
		25%	25%	50%
	Textbook/s*	1.MiniS.Thomasand JohnD. McDonald,PowerSystem SCADA and SmartGrids, CRC Press,2015.		
	OtherRefer ences	1. Janak Eknayakeatel.,SmartGrid: Technology and Applications,John Wiley and Sons, 2012. 2. H.K.Verma,e- Monographon “Smart–Grid”, www.profhkverma.info		

School: SSET		**BATCH: 2023-25**
Programme: M.Tech		**Current Academic Year: 2023-24**
Branch:EEE		**Semester: I**
1	Course Code	MPS120
2	Course Title	Energy Resources and Technology
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Departmental elective
5	Course Objective	To provide the student with 1. Various renewable energy resources available at a location 2. Familiarize with Solar energy radiation, Wind energy, hydro energy , biomass energy and other miscellaneous energy sources
6	Course Outcomes	After completion of this course students will be able to: 1. Ability to recognize the need of renewable energy technologies and their role in the India and world energy demand. 2. Understand the Principles involved in solar thermal system and solar PV system solar energy collection and conversion of it to electricity generation. 3. Explore the concepts involved in wind energy conversion system by studying its components, types and performance 4. Explore the concepts involved in hydro energy conversion system by studying its components 5. Understand the bio mass power generation. 6. Explore the concepts involved in geothermal energy, hydrogen energy, fuel cells, wave energy and tidal energy and dispersed generation. .
7	Course Description	The course is designed to familiarize and train the student to assess the various renewable energy resources and its potential at any location across the globe,.

8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Introduction to Signals and Systems**	
	A	Energy reserves and estimates	CO1
	B	Indian and global energy scenarios, environmental	CO1
	C	social and economic impacts of renewable energy use	CO1

	Unit 2	**Solar Energy**	
	A	**Solar Thermal System**: Solar radiation spectrum; radiation measurement; technology, Applications: heating, cooling, drying, distillation; solar thermal power generation.	CO2
	B	**Solar Photovoltaic System**: Operating principle, photovoltaic cell concepts, series and parallel connections	CO2
	C	I-V characteristics; maximum power point tracking; solar photovoltaic power generation.	CO2
	Unit 3	**Wind Energy**	
	A	Wind resource assessment and modeling	CO3
	B	types of wind turbines and generators,	CO3
	C	performance assessment, site selection, types of wind mills.	CO3
	Unit 4	**Hydro Energy**	
	A	Schematic arrangement of hydroelectric power station,	CO4
	B	site selection, hydro power equation	CO4
	C	large and small hydro schemes, hydro turbines and generators.	CO4
	Unit 5	**Biomass Energy and Miscellaneous Topics**	
	A	Biomass as a source of energy, types of biogas plants, biomass power generation.	CO5
	B	Introduction to geothermal energy, hydrogen energy, fuel cells,	CO5,CO6
	C	wave energy and tidal energy; hybrid energy systems, distributed energy systems and dispersed generation; need of energy storage and storage methods.	CO5,CO6
	Mode of examination	Theory	

	Weightage Distribution	CA	MTE	ETE
		25%	25%	50%

	Text book/s*	1. B.H. Khan "Non Conventional Energy Resources ", Tata McGraw-Hill Publishing Co. Limited.

School: SSET		**2023-2025**
Programme: M. Tech.		**Current Academic Year:** 2023-2024
Branch: EEE		**Semester: I**
1	Course Code	MPS123
2	Course Title	Digital Relaying for Power Systems
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Department Elective
5	Course Objective	1. To provide students with: 1. to understand the concept of digital protection and computer relaying for powers system. 2. To acquire an in- depth knowledge on different generations of protective relays 3. To identify different components of a numerical relay 4. to apply discrete Fourier transform technique in Power System Protection 5. to design and develop relay algorithms for protection of powersystem apparatus
5	Course Outcomes	After completion of this course students will be able to: CO1: To compare, analyses the advantages and disadvantages of all the three generations of protective relay and also identify the different components of a numerical relay CO2: To develop relay algorithms based on relaying signals CO3: To develop algorithm for digital protection of generator CO4: To develop algorithm for digital protection of transformer CO5: To apply ANN for protection of transmission line and power transformer CO6: To design and evaluate protection algorithms for protection of any power system component
7	Course Description	The first and foremost for advances in relaying system is need to improve reliability. This implies increase in dependability as well as accuracy. This need to reliability propelled the development of digital relaying. In this course, the students will have an exposure to the three generations of protective relays. Throughout the course, students will have an opportunity to be exposed to different numerical techniques for protection of generators, transformers and transmission lines.

8	Outline syllabus		CO Mapping
	Unit 1	**Introduction and Architecture of Digital Relay**	
	A	Three generations of protective relays: electromechanical, Static and digital/numerical	CO1
	B	architecture and elements of digital relay	CO1

	C	Multi functional relays, management relays and IED Relays			CO1
	Unit 2	**Relay Algorithms and Mathematical Basis**			
	A	Relay Algorithms based on pure sinusoidal relaying signals, distorted relaying signals and differential equation represensation of system;			CO2
	B	Z transform, sine and cosine Fourier series, FourierTransform and DFT			CO2
	C	Walsh functions, digital filters, windows and windowing.			CO2
	Unit 3	**Digital Relaying for Generator**			
	A	Various protection functions: differential, stator earth fault,loss of excitation and reverse power protection			CO3,CO6
	B	Abnormal frequency and voltage protection: over and under frequency protection, over and under voltage protection			CO3
	C	Numerical differential protection of generator			CO3,CO6
	Unit 4	**Digital Relaying for Transformer**			
	A	Types of faults encountered in transformer, basic considerations for transformerCO3 differential,			CO4,CO6
	B	Stabilizing of differential protection during magnetizing inrush current			CO4.CO6
	C	Numerical protection of transformer			CO4,CO6
	Unit 5	**Artificial Intelligence Based Numerical Protection**			
	A	Types of Neural Network Models, Artificial Neural Network, Design Procedure and Consideration			CO5,CO6
	B	Application of Ann transmission line protection			CO5,CO6
	C	Ann based power transformer protection			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book*	1.Arun G Phadke and James S. Thorp,"Computer Relaying for Power Systems",John Wiley and Sons Inc, New York. 2Badriram,D.N.Vishwakarma,„PowerStreamotection&Switchgear‟,TataMcGraw–hill Publishing Ccompany Ltd, New Delhi			
	Other References	1.BhaveshBhalja, R.P. Maheswari and Nilesh G.Chothani,"Protection and Switchgear",Oxford			

School: SSET		**Batch : 2023-25**	
Programme: M.Tech		**Current Academic Year: 2023-24**	
Branch: EEE/EE		**Semester: I**	
1	Course Code	EEE440	
2	Course Title	Modelling & Analysis of Power System	
3	Credits	4	
4	Contact Hours (L-T-P)	3-1-0	
	Course Status	Department Elective	
5	Course Objective	The course paves the foundation for exploring the ways and means to perform power system analysis in normal operation and under symmetrical and unsymmetrical faults. Models of generators, transformers and transmission lines essential for such analyses are assembled. Additionally, principles for the formulation, solution, and application of optimal power flow are established.	
6	Course Outcomes	After completion of this course students will be able to CO1: Ability to solve nonlinear algebraic and handling of sparse matrix CO2: Develop proper mathematical models for analysis of a selected problem like load flow study or fault analysis. CO3: Prepare the practical input data required for DC load flow. CO4: Select and identify the most appropriate algorithm for fault studies. CO5: Develop and apply state estimation of power system. CO6: Apply Load flow and unbalanced fault study analysis	
7	Course Description	This course will cover the modelling issues and analysis methods for the power flow, short circuit, contingency and stability analyses, required to be carried out for the power systems. Necessary details of numerical techniques to solve nonlinear algebraic as well as differential equations and handling of sparse matrices are also included.	
8	Outline syllabus		CO Mapping
	Unit 1	**Sparsity Techniques**	
	A	Storage of sparse matrix	CO1
	B	sparsity directed inversion methods	CO1
	C	parallel inversions	CO1
	Unit 2	**Three-Phase Load Flow**	
	A	Three-phase models of synchronous generator, transformer and load	CO2,CO6
	B	Load flow equations, solution techniques- Gauss-Seidel	CO2,CO6
	C	Newton Raphson method and fast decoupled method	CO2,CO6

	Unit 3	**Load Flow with HVDC link**			
	A	stem model, incorporation of control equations			CO3,CO6
	B	er and unified operation			CO3,CO6
	C	sequential solution techniques			CO3,CO6
	Unit 4	**Short Circuit Studies For Unbalanced Network**			
	A	Z-bus building algorithm, derivation of fault admittance matrices			CO4,CO6
	B	sequence components, analysis of unbalance shunt and series			CO4,CO6
	C	open circuit faults			CO4,CO6
	Unit 5	**State Estimation**			
	A	State estimation of linear and nonlinear systems, pseudo-measurements.			CO5
	B	Recursive method and weighted least square estimation method			CO5
	C	Detection and identification of bad measurements, network observability.			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	Arrillaga J. and Arnold C.P., " Computer Analysis of Power Systems", John Wiley & Sons			
	Other References	1. Kusic G.L., "Computer Aided Power System Analysis", CRC Press. 2. Anderson P.M., "Analysis of Faulted Power Systems", Wiley-IEEE Press.			

School: SSET		**2023-2025**
Programme: M. Tech.		**Current Academic Year:** 2023-2024
Branch: EEE		**Semester: I**
1	Course Code	MPS117
2	Course Title	Power System Operation and Control
3	Credits	4
4	Contact Hours (L-T-P)	3-1-0
	Course Status	Department Elective
5	Course Objective	1. Learn modern techniques and analytical methods for dealing with and solving operation related problems in electric power system.
5	Course Outcomes	After completion of this course students will be able to: CO1: Explore the concept of automatic generation control CO2: Apply methods of excitation systems and exercise voltage control. CO3: Employ incremental cost curve and penality factor for economic operation CO4: Plan unit commitment for optimal operation CO5: Evaluate power system security and method of improvement CO6: Apply mathematical and engineering fundamentals required to control and operation of power system.
7	Course Description	This course aims to convince the student that constancy of frequency and voltage is the primary health indicator of the power system for maintaining the real and reactive power balance in systems. The concept of economic load dispatch and unit commitment are also given in the course. The concept of close coordination between thermal and hydro power plant to meet the load demand has beem included in the course.

8	Outline syllabus		CO Mapping
	Unit 1	**Economic Dispatch of Thermal Units**	
	A	Economic dispatch problem with and without losses	CO3,CO6
	B	Solution methods-Lamda iteration technique, gradient search and Newton’s method	CO3,CO6
	C	Solution methods-priority list and dynamic Programming	CO3,CO6
	Unit 2	**Unit Commitment**	
	A	Unit commitment problem, start up and shut down cost	CO4,CO6
	B	Thermal unit constraints, hydro constraints and other constraints	CO4,CO6
	C	Solution methods-priority list and dynamic Programming	CO4,CO6
	Unit 3	**Hydro-Thermal coordination**	
	A	Long term and short term hydro thermal coordination	CO6
	B	Solution by gradient method	CO6
	C	Pumped storage hydro power plant scheduling, pumped storage hydro plant scheduling.	CO6
	Unit 4	**Power System Security**	
	A	Security analysis	CO5,CO6

	B	Contingency analysis methods			CO5.CO6
	C	Contingency selection			CO5,CO6
	Unit 5	**Load Frequency and Excitation Control**			
	A	Generation model, load model, prime mover model, governor model, tie line model			CO1,CO2,CO6
	B	Automatic generation control of single area, inter connected areas, steady state and dynamic analysis, two area load frequency control			CO1,CO2,CO6
	C	Types of excitation control, Reactive power control and voltage collapse			CO1,CO2,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book*	1.Allen J.Wood and Bruce F. Wollenberg,"Power Generation Operation and Control" John Willey and Sons,inc.2003.			
	Other References	1.P.Kundur,"Power System Stability and Control", McGraw Hill Publisher, USA,1994. 2.Olle .I.Elgerd,"Electric Energy Systems Theory An Introduction"Tata Mcgraw Hill Publishinh Company Ltd. New Delhi, second edition, 2003.			

School: SSET		**Batch : 2023-2025**	
Programme: M. Tech.		**Current Academic Year: 2023-2024**	
Branch: EEE		**Semester: I/II**	
1	Course Code	MPS133	
2	Course Title	Electric and Hybrid Vehicles	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Department Elective	
5	Course Objective	This course is designed to give an overview of electric and hybrid vehicles, electric propulsion and energy storage.	
5	Course Outcomes	After completion of the course, the student will be able to **CO1:** Describe the configuration and performance of Electric vehicles **CO2:** Design the structure of Hybrid Electric Vehicle **CO3:** Describe the operation of Fuel Cells and solar cars **CO4:** Explain Electric propulsion system and Motor control systems **CO5:** Discuss energy storage devices and generators **CO6:** Understand the performance characteristics of electric hybrid vehicles	
	Course Description	Hybrid Electric Vehicle Course is a professional course wherein students are taught dynamics, charging, battery assembling, designing engines, interior and exterior spacing, etc. of hybrid electric vehicles.	
8	Outline syllabus		CO Mapping
	Unit 1	**Electric Vehicles**	
	A	Introduction, Layout of an Electric Vehicle, Performance of Electric Vehicles, Traction Motor Characteristics	CO1,
	B	Tractive Effort and Transmission Requirements , Vehicle Performance , Energy Consumption,	CO1
	C	Advantages and Limitations, Specifications, System Components, Electronic Control System.	CO1
	Unit 2	**Hybrid Vehicles**	
	A	Concepts of Hybrid Electric Drive Train,	CO2,CO6
	B	Architectures of Series Hybrid Electric Drive Trains, Architectures of Parallel Hybrid Electric Drive Trains, Merits and Demerits,	CO2.CO6
	C	Series Hybrid Electric Drive Train Design, Parallel Hybrid Electric Drive Train Design.	CO2,CO6
	Unit 3	**Fuel Cells & Solar Cars**	
	A	Photovoltaic Cells, Tracking, Efficiency, Solar Cars,	CO3,
	B	Fuel Cells - Construction & Working, Equations, Possible Fuel Sources,	CO3
	C	Fuel Reformer, Design, Cost Comparison.	CO3,
	Unit 4	**Electric Propulsion System And Motor Control System**	CO3

	A	DC Motors Characteristics, Speed and Torque Control, Regenerative Braking.			CO4, CO6
	B	AC Motors Characteristics, Speed and Torque Control.			CO4, CO6
	C	PM- BLDC Motors Characteristics, Speed and Torque Control.			CO4, CO6
	Unit 5	**Energy Storages & Generators**			
	A	Electrochemical Batteries: Types of Batteries, Lead-Acid Batteries, Nickel Based Batteries, Lithium Based Batteries,			CO5
	B	Electro Chemical Reactions, Thermodynamic Voltage, Specific Energy, Specific Power, Energy Efficiency			CO5, CO6
	C	Ultra Capacitors, DC Generators, AC Generators, Voltage and Frequency Regulations			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book*	Hingorani N. G. and Gyugi L., "Understanding FACTS: concepts and technology of Flexible AC Transmission systems", Wiley IEEE Press, 1999			
	Other References	1. Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design", CRC Press, 2004. 2. James Larminie and John Loury, "Electric Vehicle Technology – Explained", John Wiley & Sons Ltd, 2003. 3Sandeep Dhameja, "Electric Vehicle Battery Systems", Butterworth – Heinemann, 2002. 4. Ronald K Jurgen, "Electric and Hybrid – Electric Vehicles", SAE, 2002. 5) Ron Hodkinson and John Fenton, "Light Weight Electric/Hybrid Vehicle Design", Butterworth – Heinemann, 2001. 5. Iqbal Husain, "Electric and Hybrid Vehicles- Design Fundamentals" CRC Press, 2011.			

School: SSET		**Batch: 2023-2025**	
Programme: M Tech		**Current Academic Year: 2023-24**	
Branch: EEE		**Semester: I/II**	
1	Course Code	EEP-621	
2	Course Title	SMART POWER GRID AND MICRO GRID LAB	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	Compulsory	
5	Course Objective	To provide students with: 1. To get practice on PSCAD software 2. To develop concepts of automatic grid on the software.	
6	Course Outcomes	After completion of this course the students will be able to CO1: Able to develop simulation of concept of 1 phase and 3 phase sources. CO2: Able to develop simulation of concept of metering CO3: Able to develop simulation of converter and inverter circuit CO4: Able to develop simulation of switching of sources CO5: Able to develop simulation of paralleling of sources CO6: Able to develop circuit for generation, transmission, distribution	
7	Course Description	The contents of this course cover the measurement of different electrical parameters of substation. Concepts of measurements will be done using PSCAD.	
8	Outline syllabus		CO Mapping
	Unit 1	**Study of simulation software**	
	A	Study of a generator functions and do simulation on the software	CO1
	B	Study of inverter and converter functions in the simulation software.	CO1
	C	Study of measurement functions in simulation software.	CO1
	Unit 2	**Simulation on generation and conversion modules**	
	A	Simulation of generation of Power Source.	CO2
	B	Simulation of single-phase inverter.	CO2
	C	Measurements with the simulated generator and inerverter	CO2
	Unit 3	**Simulations on single-phase systems**	
	A	Simulation of single-phase converter.	CO3
	B	Simulation of combining of inverter and converter.	CO3
	C	Measurements with the above simulated modules	CO3
	Unit 4	**Single-phase systems with different loads**	

	A	Simulation of single-phase inverter with R load.			CO4
	B	Simulation of single-phase inverter with R-L load.			CO4
	C				CO4
	Unit 5	**Simulations on three-phase systems**			
	A	Simulation of three phase generator.			CO5
	B	Simulation of three phase generator and transformer.			CO5,CO6
	C	Measurements with the above simulated modules			CO5,CO6
	Mode of examination	Practical & Viva			
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	
	Text book/s*	Lab Manuals			
	Other References	Interface MATLAB - PSCAD/EMTDC Software for Integrated Simulation, LAP Lambert Academic Publishing			

School: SSET		Batch : 2023-25	
Programme: M.Tech		**Current Academic Year: 2023-24**	
Branch:EEE		**Semester: I/II**	
1	Course Code	MPS116	
2	Course Title	Power System Reliability Assessment	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Department Elective	
5	Course Objective	1. Objective of the course is to apply the knowledge of students in the field of probability analysis to evaluate the reliability of power system. 2. The concepts of reliability function, network modelling, and concept of frequency ad duration technique will be discussed to significant depth for improving reliability in generation, interconnected and distribution systems	
6	Course Outcomes	On successful completion of this course students will be able to CO1: evaluate reliability functions and probability distributions CO2: demonstrate network modelling and to evaluate various systems CO3. Design and evaluate the generation system model CO4: employ equivalent assistance unit method for reliability evaluation of inter-connected system CO5: discuss the elementary concepts for reliability evaluation of distribution system CO6:Apply reliability evaluation in power system	
7	Course Description	This course gives an introduction to the main principles and objectives of power system reliability analysis: Basic terms and definitions, applications, overview of methodologies for contingency analysis and reliability analysis, reliability models, reliability indicators and main results such as interruptions and societal impact. The following topic are discussed : reliability analysis of transmission and distribution systems, analysis of time dependencies and interruption costs, protection system reliability and impact on reliability of supply.	
8			CO Mapping
	Unit 1	**Review of Probability Theory**	
	A	Probability concepts, rules for combining probability, probability distributions.	CO1
	B	Random variables, density and distribution functions.	CO1
	C	Mathematical expectations, variance and standard deviation.	CO1
	Unit 2	**Basic Reliability Evaluation**	
	A	General reliability functions, probability distributions in reliability evaluation.	CO2,CO6

	B	Network modeling and evaluation of series, parallel, series –parallel and complex systems, cut-set method, tie-set method, discrete Markov chains, continuous Markov process.			CO2,CO6
	C	Concept of frequency and duration technique, application to multi-state problems, approximate system reliability evaluation methods.			CO2,CO6
	Unit 3	**Generation System Reliability**			
	A	Generation system models, capacity outage table, recursive algorithm.			CO3,CO6
	B	Loss of load indices, inclusion of scheduled outages, load forecast uncertainty, loss of energy indices.			CO3,CO6
	C	Expected energy generation, energy limited systems, reliability evaluation, frequency and duration method.			CO3,CO6
	Unit 4	**Interconnected System Reliability**			
	A	Probability array method in two inter-connected systems, effect of tie capacity, tie reliability and number of tie lines.			CO4,CO6
	B	Equivalent assistance unit method for reliability evaluation of inter-connected system.			CO4,CO6
	C	Elementary concepts of reliability evaluation of multi-connected systems, composite system reliability.			CO4,CO6
	Unit 5	**Distribution System Reliability**			
	A	Basic technique and application to radial systems, customer–oriented indices, load and energy indices.			CO5,CO6
	B	Effect of lateral distributor protection, effect of disconnects effect of protection failures, effect of load transfer.			CO5,CO6
	C	Meshed and parallel networks, approximate methods, failure modes and effects analysis, inclusion of scheduled maintenance, temporary and transient failures, inclusion of weather effects.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	R. Billinton and R.N.Allan, "Reliability Evaluation of Power Systems", Pitman Advanced Publishing Programme			
	Other References	1. R.Billinton and R.N.Allan, "Reliability Evaluation of Engineering Systems Concepts and Techniques", Pitman Advanced Publishing Programme. 2. J.Endrenyi, "Reliability Modeling in Electric Power Systems", John Wiley & Sons.			

School: SSET		**Batch :** 2023-2025	
Programme: M. Tech.		**Current Academic Year:** 2023-2024	
Branch: EEE		**Semester: I/II**	
1	Course Code	MPS124	
2	Course Title	FACTS Devices and Systems	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Department Elective	
5	Course Objective	art the students with various FACTS devices which are used for proper operation of existing AC system more flexible in normal and abnormal conditions	
5	Course Outcomes	After completion of the course, the student will be able to CO1: Understand the power flow control in transmission lines. CO2: Analyze the operation of Voltage source converter CO3: Understand the operations of Shunt controllers. CO4: Understand the operations of Series controllers. CO5: Analyze the different FACTS devices in different stability conditions. CO6: Understand operation of hybrid controllers and select an appropriate FACTS device for a particular application	
7	Course Description	FACTS is the acronym for Flexible AC Transmission Systems and refers to a group of resources used to overcome certain limitations in the static and dynamic transmission capacity of electrical networks. The main purpose of these systems is to supply the network as quickly as possible with inductive or capacitive reactive power that is adapted to its particular requirements, while also improving transmission quality and the efficiency of the power transmission system. FACTS Devices course is designed to provide in-depth knowledge to provide actual hardware solution of the FACTS.	
8	Outline syllabus		CO Mapping
	Unit 1	**Power transmission control**	
	A	Power flow control, steady state and dynamic limits of power transmission	CO1
	B	Transmission line compensation	CO1
	C	Objectives of FACTS devices	CO1
	Unit 2	**FACTS Controller**	
	A	Shunt connected controllers, series connected controllers	CO2
	B	Combined shunt and series connected controllers	CO2
	C	Voltage-source converters	CO2
	Unit 3	**Shunt and Series Compensation**	
	A	Principal of operation and configuration of SVC and STATCOM	CO1,CO3, CO4
	B	V-I and V-Q characteristics, operation with unbalanced system,	CO1,CO3,

		applications of SVC and STATCOM			CO4
	C	Principal of operation and configuration of TCSC and SSSC			CO1,CO3, CO4
	Unit 4	**Unified power flow controller**			
	A	Basic operating principles			CO4,C06
	B	Characteristics of UPFC			CO4,C06
	C	Dynamic performance, steady state analysis and control			CO4,C06
	Unit 5	**Stability analysis**			
	A	Oscillation stability analysis			CO5
	B	Transient stability control			CO5
	C	Protection issues with FACTS device			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	2\5%	50%	
	Text book*	Hingorani N. G. and Gyugi L., "Understanding FACTS: concepts and technology of Flexible AC Transmission systems", Wiley IEEE Press, 1999			
	Other References	1. Acha E., Fuerta-Esquivel C. R., Ambriz-Perez H. and Angeles-Camacho C., "FACTS modeling and simulation in power networks", John Wiley & Sons Ltd., England, 2004 2. Song Y. H. and Johns A. T, "Flexible AC Transmission Systems", IEE Power Series, IET, 2000 3. Mathur R.M. and Verma R.K., "Thyrister Based FACTS Controller for Electric Transmission System", Wiley Interscience, 2002			

School: SSET		**BATCH: 2023-25**
Programme: M.Tech		**Current Academic Year: 2023-24**
Branch:EEE/ I&A andI&C		**Semester: I/II**
1	Course Code	MIC101
2	Course Title	Analog and Digital Signal Processing
3	Credits	4
4	Contact Hours (L-T-P)	3-1-0
	Course Status	Department Elective
5	Course Objective	To provide the student with 3. Concepts so as to categories various types of Signals and Systems. 4. İn-depth knowledge so that implementation of circuits related to linearapplications of the op-amp are achievable. 5. Basic understanding for the implementation of active filters usingop-amp. 6. Strong foundation for designing of Digital Systems both FIR and IIRand analyses of systems using DFT and FFT.
6	Course Outcomes	After completion of this course students will be able to: CO1: To categories the various types of signals and systems and to perform various mathematical operations on signals. CO2: To differentiate and design various applications of op-Amp. CO3: To design OP-AMP based Filters CO4: Design iir digital filters using various techniques CO5: To do frequency analysis using DFT and FFT. CO6: To design and implement various types of digital filters.
7	Course Description	The course content of this subject includes introduction of signals and systems.It also covers the various linear and nonlinear applications of the op-Amp. Also the content elaborates the designing and implementation of digital filters alongwith DFT and FFT as the main frequency tool.
8	**Outline syllabus**	**CO Mapping**
	Unit 1	**Introduction to Signals and Systems**

	A	Continuous-time and discrete-time signals and their mathematical representation, analog and digital signals,	CO1
		analog signal processing (ASP) and digital signal processing (DSP)	CO1
	B	Signal , Continuous time signals (CT signals), discrete time signals (DT signals) - Step, Ramp, Pulse, Impulse, Exponential, Classification of CT and DT signals - periodic and aperiodic, Even and Odd, Power and Energy Invertible and Non-invertible, Deterministic and Random	CO1
	C	System,Basic Types of Systems- Causal and Non-causal, Stable and Unstable, Static and Dynamic.Linear and Non-Linear Time Variant and Time Invariant, Basic operations on signals - addition, multiplication, shifting, folding, etc.	CO1
	Unit 2	**Linear Applications of Opamp**	
	A	Operational amplifier: block diagram, equivalent circuit,ideal and practical operational amplifier; inverting and non-inverting amplifier circuits	CO2
	B	Practical Integrator and Differentiator circuits,	CO2
	C	Summing and differential amplifier circuits; Instrumentation amplifier	CO2
	Unit 3	**Op-amp based Filters**	
	A	Passive and active filters, their comparison; frequency response of low- pass, high- pass ,band- pass, band- stopand notch filters and their use in instrumentation;	CO3
	B	Active filters: Basic low- pass filter circuit , first and second order low- pass and high- pass Butterworth filters	CO3
	C	Band- pass filter, Band reject (notch) filter, Concept of higher order filter realization	CO3
	Unit 4	**Digital Filters**	
	A	Design of Digital Filters----- Design of FIR Filters: Symmetric and Anti-symmetric FIR Filters. Design of Linear phase FIR Filter using Windows, Gibbs phenomenon.	CO4,CO6
	B	Design of IIR Filters: Design by Approximation of	CO4,CO6
		Derivatives, Impulse Invariance and by Bilinear Transformation.	CO4,CO6
	C	Direct form-1 and form-2 realizations, Cascade and Parallel realizations, recursive and non-	CO4,CO6

		recursivemethods of realizations.		
	Unit 5	**Frequency Analysis**		
	A	Digital Fourier transform (DFT),		CO5
	B	DFT algorithm for frequency analysis		CO5
	C	Fast Fourier transform (FFT), FFT algorithm for frequency analysis.		CO5
	Mode of examination	Theory		
	Weightage Distribution	CA	MTE	ETE
		25%	25%	50%
	Text book/s*	1. *Ramakant A.Gayakwad, "Op-Amp and Linear Integrated Circuits" Pearson Education, 4th Edition* 2. *Sedra and Smith, "Microelectronic Circuits", 4th Edition, Oxford University Press.* 3. *G. Proakis and D.G. Manolakis, "Digital Signal Processing,Principals, Algorithms, and Applications", Pearson Education,*		
	Other References	1. *A. Y. Oppenhein, R. W. Schater and J. R. Buck, "Discrete Time Signal Processing", PHI 1999* 2. *Michael Jacob, "Applications and Design with Analog IntegratedCircuits, PHI,2nd Edn.2006* 3. *Jacob Milliman and Arvin Grabel, "Microelectronics" , 2nd Edition ,TMH, 2008*		

School: SSET		Batch : 2023-25
Programme: M.Tech		**Current Academic Year: 2023-24**
Branch: EEE		**Semester: I/II**
1	Course Code	MIC008
2	Course Title	Virtual Instrumentation
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Departmental Elective
5	Course Objective	To provide students with: 1. Introduction to the various models of Virtual Instruments, their comparison with traditional instruments and major application areas of VI. 2. Introduction to basics of LabVIEW 3. VI Programmeming techniques like loops, arrays, clusters, plotting andStrings and files. 4. Basics of signal conditioning techniques along with DAQ hardware and software and various signal processing techniques available in LABVIEW. 5. Advanced concepts in LabVIEW with main concepts of real time applications in Image acquisition and Motion control. 6. Building of Virtual Instruments with various types of controls and indicators. 7. Configuring DAQ card and acquisition of real time signals from sources and sensors. 8. Simulate a signal in LabVIEW and generate a virtual source using DAQ cards.
6	Course Outcomes	After completion of this course students will be able to: CO1. Distinguish among various models of Virtual instrumentation and contrast between traditional and virtual instruments. CO2. Select various components from various pallets from LabVIEW, required for the development of VI. CO3. Apply various Programming functions of LabVIEW like loops, arrays, clusters and file I/Os for building of simple Virtual instruments. CO4. Develop Data acquisition modules and apply basic signal processing techniques available in LabVIEW. CO5. Design the real time applications of LabVIEW in motion control and Image acquisition. CO6.Build a Virtual Instrument using LabVIEW Platform.
7	Course Description	The course content of this subject includes an introduction to graphical

		system design. This course also focuses on introduction to LabVIEW which extensively elaborate the Graphical Programming language In Unit 3, building of VI by using loops, arrays, clusters etc. have been dealt with. Use of strings and I/O are also elaborated in this course. Data acquisition and various signal processing techniques are also covered in this course. Two real time applications motion control and Image acquisition by using LabVIEW have been elaborated in this course.		
8	Outline syllabus			CO Mapping
	Unit 1	**Introduction**		
	A	Graphical system design model - design model, prototype model, deployment model		CO1
	B	Building blocks of VI; Virtual instrument versus traditional instrument, Hardware and software in VI		CO1
	C	Graphical system Design using LabVIEW; Graphical Programming and Textual Programming		CO1
	Unit 2	**Graphical system Design using LabVIEW**		
	A	Advantages of LabVIEW; Components of VI Software - Front panel windows, Block diagram windows, Icon /connector pane		CO2
	B	Creating and saving a VI; Toolbars, Palettes, Front panel controls and indicators, Block diagram – terminals, nodes, functions		CO2
	C	Sub VIs, Express VIs and VIs, wires; Data types, Data flow Program		CO2
	Unit 3	**Programming Techniques**		
	A	Modular Programming in Lab View; Building VI front panel and block diagram		CO3
	B	Loops – for and while loops, Local and Global variables in LabVIEW, Arrays in LabVIEW,		CO3
	C	Clusters in LabVIEW; Conversion between arrays and clusters, Plotting data in LabVIEW, Strings and File I/O in LabVIEW		CO3
	Unit 4	**Data Acquisition and Signal Processing in LabVIEW**		
	A	Transducers and Signal conditioning, sampling and aliasing		CO4
	B	Basics of DAQ hardware and software, DAQ modules and drivers for building virtual instruments		CO4
	C	Fourier transforms; Power spectrum, Correlation methods; Windowing & filtering		CO4
	Unit 5	**Advanced concepts in LabVIEW**		
	A	Data Socket, TCP/IP VI‟s synchronization		CO5,
	B	Serial interface buses - RS 232, RS485,USB		CO5
	C	Concepts of real time systems; Image acquisition; Motion control		CO5
	Mode of examination	Theory		
	Weightage	CA	MTE	ETE

	Distribution	25%	25%	50%
	Text book/s*	1. Jovitha Jerome, "Virtual Instrumentation andLABVIEW", PHI Learning		
	Other References	1. C.L. Clark, "LabVIEW Digital Signal Processing",TMH Publishing Company. a. Technical Manuals for DAQ Modules, Advantechand National Instruments 2. www.profhkverma.info: Chapter 2: Technologies/Protocols for Wired Sensor Network 3. NI USER MANUAL http://www.ni.com/pdf/manuals/376445b.pdf 4. www.ni.com		

School: SSET		Batch : 2023-25	
Programme: M.Tech		Current Academic Year: 2023-24	
Branch: EEE		Semester: I/II	
1	Course Code	MIA116	
2	Course Title	Industrial Network Protocols and IoT	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Departmental Elective	
5	Course Objective	To provide students with: 1. basic principles network communications and communication system modelsand it's seven layers. 2. In depth knowledge of wired and wireless network protocols. 3. With the concept of IoT, M2M and IIoT along with typical applications thereof.	
6	Course Outcomes	After completion of this course students will be able to: CO1: To be able to understand the principles and types of data networks, especiallythose used in industry. CO2: Have in-depth knowledge of industrial wired network protocols and theircomparative merits and limitations. CO3:To be able to apply Ethernet/IP protocol for industrial control and automation applications. CO4: To be able to select and apply wireless network protocol for instrument controland automation for industrial and societal applications. CO5: To be able to apply the concepts of IoT and design IoT system. CO6: Design IoT-based systems for real-world problems	
7	Course Description	This course is aimed at equipping students with in-depth knowledge various industrial network protocols, both wired and wireless types and a working knowledge of the IoTconcepts and systems.	
8	Outline syllabus		CO Mapping
	Unit 1	Basics	
	A	Principles of analog and digital communication and their comparison; Asynchronous and synchronous data transmission; Simplex, half duplex and full duplex transmissions; Baseband and broadband communications; Signal transmission media: UTP,STP and coaxial cables, PLCC, optical fibres and radio link;	CO1
	B	Concept of LAN, PAN,MAN,WAN and Internet; Error detection techniques: Parity check, check sum and CRC; LAN topologies; Role of data communication and networks in industrial automation; Field-level, control-level and enterprise-level networks;	CO1

	C	ISO‟s seven-layer OSI model: significance, scope, functions of various layers; IEC‟s four-layer EPA model: significance, functions of various layers; MAC techniques: reservation, selection and contention techniques, polling, token passing, CSMA/CD ; Special requirements of industrial network protocols, list of important industrial wired and wireless network protocols.	CO1

	Unit 2	**Industrial Wired–Network Protocols**	
	A	**Fieldbus:** Meaning and characteristic features of fieldbus,popular fieldbuses. **RS485**: Highlights, balanced–mode transmission in half duplexand full duplex modes, MAC protocol, merits and limitations. **Modbus:** Modbus protocol stack, Modbus address space andobjecttypes, data transmission frame formats for Modbus/RTU, Modbus/ASCII and Modbus/TCP, formats of data requests and responses for main function codes (examples only), merits and limitations of Modbus	.CO2
	B	**Foundation Fieldbus**: FF protocol stack; physical layer, topologies supported, data link layer: FDLC and FMAC, application layer, merits and limitations of FF.	CO2
	C	**Distributed Network Protocol:** DNP protocol stack, DNP version 3.3, physical layer and physical topologies, data link layer, pseudo-transport layer, application layer, merits and limitations of DNP3.	CO2
	Unit 3	**Ethernet and Ethernet /IP**	
	A	**Ethernet:** IEEE802.3, physical layer, speed variants of Ethernet, MAC and frame format; TCP/IP model; Ethernet LAN components: repeater, bridge, router, gateway, hub and switch; Merits and limitations of Ethernet for industrialapplication	CO3
	B	Common Industrial Protocol (CIP)	CO3
	C	**Ethernet/IP:** Adaption of Common Industrial Protocol (CIP) to standard Ethernet, UDP, comparison between standardEthernet and Ethernet /IP.	CO3
	Unit 4	**Industrial Wireless Network Protocols**	
	A	**Zigbee:** Special features, IEEE802.15.4, data rates, ISM- frequency bands used and bandwidths, full-function and reduced-function devices, PAN coordinator, MAC protocoland data transfer types	CO4
	B	Wireless network topologies	CO4
	C	**Comparison** of Zigbee with Wi-Fi and Bluetooth.	CO4
	Unit 5	**IoTand Industrial IoT**	
	A	IoT concept and definition; Technologies behind IoT;	CO5

	B	CISCO"s 7-tier IoT reference model; Components of IoT devices; M2M communication; Relation between IoT, M2Mand IIoT; Modified OSI model for IoT/M2M/IIoT;			CO5,CO6
	C	Examples of applications of IoT, M2M and IIoT.			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1. William Stallings, "Data and Computer Communications",8th Edition, Pearson Prentice Hall, 2007. 2. Mini S. Thomas and John D. McDonald, "Power SystemSCADA and Smart Grids", CRC Press, 2015. 3. Raj Kamal, "Internet of Things: Architecture and DesignPrinciples", Mc Graw Hill Education, 2017.			
	Other References	1. David Bailey and Edwin Wright, "Practical SCADA for Industry", Newnes, 2009. 2. S.K. Singh, "Industrial Instrumentation and Control", Tata McGraw-Hill, 2003. 3. M.M.S. Anand, "Electronic Instruments and InstrumentationTechniques", Prentice Hall, 2004. 4. H.K. Verma, Sensor Networks, e-monograph at www.profhkverma.info, Chapter 2 – Wired Network Technologies/Protocols, Chapter 3 – Wireless NetworkTechnologies/Protocols. 5. H.K. Verma, SCADA, e-monograph at www.profhkverma.info, Chapter 4: Network Technologies Deployed in SCADA Systems.			

School: SSET		**Batch : 2023-25**	
Programme: M.Tech		**Current Academic Year: 2023-24**	
Branch: EEE		**Semester: I/II**	
1	Course Code	MIA118	
2	Course Title	Industrial Robotics	
3	Credits	2	
4	Contact Hours (L-T-P)	2-0-0	
	Course Status	Compulsory /Elective/Open Elective	
5	Course Objective	To provide students with: 1.The conceptual as well as practical knowledge of the Industrial Automation & latest technologies being used to achieve Industrial Automation.	
6	Course Outcomes	After completion of this course students will be able to: CO1: Able to identify type of robots CO2: Able to identify parts of robots CO3: Able to select sensor for robots CO4: Able to understand circuits for robots CO5: Able to explain about industry robots CO6: Able to select robots for a particular application	
7	Course Description	This course is aimed at equipping students with appropriate knowledge and skills required in configuring, Programming and operating Industrial automation systems with the use of Industrial Field Instruments, PLCs, SCADA/ HMI and DCS.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Robotics and Motion Analysis**	
	A	Historical background; Laws of robotics and robot definitions;	CO1
	B	Robotics systems and robot anatomy: Basic diagram, basic components	CO1
	C	Specifications of robots.	CO1
	Unit 2	**Robot End-Effectors, Robot Drives and Actuators**	
	A	Classification of end-effectors; Mechanical grippers, Magnetic grippers	CO2
	B	BLDC motors, stepper motor	CO3
	C	Servo motors, piezoelectric actuators;	CO2, CO6
	Unit 3	**Sensors of Robotic System**	
	A	Obstacle Sensors	CO4
	B	Proximity sensors	CO4
	C	Other sensors	CO4, CO6
	Unit 4	**Controlling Technologies of Industrial Robots**	
	A	Controllers in robotics	CO5

	B	Interfacing in robotics			CO5
	C	Communications in robotics			CO5
	Unit 5	**Industrial Robot Applications**			
	A	Material handling robots;			CO5
	B	Welding Robots;			CO5, CO6
	C	Assembling robots;			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	S.R. Deb and S. Deb, "Robotics Technology and Flexible Automation", Second edition, McGraw Hill, 2011 Mikell P Groover et al., "Industrial Robotics", fifth print, McGraw Hill, Special Indian Edition, 2013			

School: SSET		**2023-2025**	
Programme: M. Tech.		**Current Academic Year: 2023-2024**	
Branch: EEE		**Semester: I/II**	
1	Course Code	MIA153	
2	Course Title	Virtual Instrumentation Lab	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	Department Elective	
5	Course Objective	To provide students with: 1. To develop VI supporting various types of data. 2. To generate and acquire real time signals using DAQ cards and LabVIEW. 3. To develop VI using LabVIEW and DAQ cards.	
6	Course Outcomes	After completion of this course students will be able to: CO1: To select appropriate controls, indicators and functions from the various pallets of LabVIEW. CO2: To implement arithmetic and Boolean systems using LabVIEW. CO3: To create VI using arrays. CO4: To build VI using cluster operations of LabVIEW. CO5: To acquire and generate signals using DAQ cards. CO6: Build VI for simulated and real time applications using LabVIEW and DAQ cards	
7	Course Description	The main focus of this course is to give hands on training to the students on the LabVIEW software. It aims at the acquisition and generation of the real time signals. Design and development of real time VI using the DAQ cards and LabVIEW are covered in it.	
8	Outline syllabus		CO Mapping
	Unit 1	**Practical related to --**	
	A	To study various types of numeric controls and indicators and numeric Programmeming functions available in function palate. Create the front panel and block diagram of VI to show the trigonometric values of sine and cosine of a given angle in degrees	CO1
	B	To study various types of Boolean controls and Indicators. Also study various Boolean Programmeming functions available in function palate. Create a VI to compute the Boolean expression (A*B) +(C*D*E).	CO1
	C	Create a front panel and block diagram to implement half ladder and full adder. To create front Panel of CRO, Meters and Function Generator	CO1

	Unit 2	**Practical related to --**			
	A	Create a VI to create 2D numeric arrays & add them.			CO2
	B	Create a VI consisting of two clusters of LEDs Perform the AND operation between the clusters and display the output in another clusters of LEDs.			CO2
	C	Create a VI using cluster to display information of student, name, age, status, marks. Use Bundle and Unbundle Functions.			CO2
	Unit 3	**Practical related to --**			
	A	Create a VI to acquire an analog signal from a source using USB6008.			CO3
	B	Also extract the information related to the various voltage parameters and frequency of this signal.			CO3
	C	Acquire an analog signal of LM35 temperature sensor on a DAQ signal accessory. Plot its Characteristics using graph function in LabVIEW.			CO3
	Unit 4	**Practical related to --**			
	A	Create a VI to produce voltage output from 0 to 10 volts in steps of 0.5 volts. View the same on the CRO using an appropriate DAQ card.			CO4
	B	Design controller for the automation of temperature and humidity in LabVIEW.			CO4
	C	Design a Virtual Resistance Meter			CO4
	Unit 5	**Practical related to --**			
	A	Design a virtual sinusoidal voltage source			CO5
	B	Design a Virtual CRO.			CO5, CO6
	C	Design a multifunction voltage meter.			CO5, CO6
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	
	Text book*	1.Jovitha Jerome, "Virtual Instrumentation and LABVIEW", PHI Learning			

	Other Referenc es	1. C.L. Clark, “LabVIEW Digital Signal Processing”, TMH Publishing Company 2. Technical Manuals for DAQ Modules, Advantech and National Instruments. 3. NI USER MANUAL http://www.ni.com/pdf/manuals/376445b.pdf	

School: SSET		Batch : 2023-2025
Programme: M. Tech.		**Current Academic Year: 2023-2024**
Branch: EEE/PS		**Semester: I/II**
1	Course Code	MPS134
2	Course Title	Power Quality
3	Credits	2
4	Contact Hours (L-T-P)	2-0-0
	Course Status	Department Elective
5	Course Objective	understand the significance of power quality, its types and to study various harmonic indices, voltage quality issues and its mitigation.
5	Course Outcomes	After completion of the course, the student will be able to **CO1:** Understand the significance of power quality, its types and to study various harmonic indices **CO2:** To study the various types of harmonics and its effects on rotating machines and various control and protection strategies. **CO3:** Analyze various types of filters and its configuration with different types of control strategies. **CO4:** Understand the various voltage quality standards and the sources of unbalanced voltages and harmonics. **CO5:** Understand various voltage quality improvement devices and its operation. **CO6:** Understand the power quality issues and methods to reduce them.
	Course Description	Power Quality is the measurement of how close to perfect an electrical voltage is at any given point time or point. High quality electrical voltage is a sine wave that measures exactly what is expected in both voltage and frequency. Power quality is a very important issue that should be addressed as poor power quality costs money and in some cases downtime. The course is designed to understand power quality issues in modern power system and methods to mitigate them.

8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Significance of power quality, Various power quality parameters,	CO1,CO6
	B	Voltage vs Current distortion,	CO1,CO6
	C	Harmonic indices – THD, TDD; Harmonic analysis, Harmonic phase sequence, Triplen harmonics, Inter harmonics	CO1,CO6
	Unit 2	**Harmonic effects**	
	A	Sources of harmonics, Resonance	CO2
	B	Effects of harmonics on rotating machine, power system protection,	CO2

	C	Consumer equipment, communication systems			CO2
	Unit 3	**Harmonic elimination**			
	A	Passive filters – design, advantages and disadvantages;			CO3, CO6
	B	Shunt active filters – Principle of operation, configurations			CO3,CO6
	C	design and control strategies			CO3,CO6
	Unit 4	**Voltage Quality**			CO3
	A	Sources of Sags, Swell, Unbalance and Harmonics			CO4,CO6
	B	Voltage quality standards, effects of Sags, Swell,			CO4
	C	Unbalance and Harmonics; Voltage sag due to faults			CO4
	Unit 5	**Voltage Quality Improvement**			
	A	Principle of operation, configuration of active power filters			CO5, CO6
	B	design and control strategies of series active power filters			CO5
	C	Principle& Working of DSTATCOM – DSTATCOM in Voltage control mode, current control mode, DVR Structure			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book*	1. Roger. C. Dugan, Mark. F. Mc Granagham, Surya Santoso, H.WayneBeaty, "Electrical Power Systems Quality", McGraw Hill,2003 2. J. Arrillaga, N.R. Watson, S. Chen, "Power System Quality Assessment", (New York : Wiley),2000. 3. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad," Power Quality Problems & Mitigation Techniques" Wiley, 2015.			
	Other References	1. G.T. Heydt, "Electric Power Quality", 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994. 2. M.H.J Bollen, "Understanding Power Quality Problems: Voltage Sags and Interruptions", (New York: IEEE Press), 2000.			

School: SSET		Batch : 2023-25	
Programme: M.Tech		**Current Academic Year: 2023-24**	
Branch:EEE		**Semester: I/II**	
1	Course Code	ECE619	
2	Course Title	Internet of Things and Applications	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Elective	
5	Course Objective	To provide students with: 1. Emphasize the application areas of IoT 2. Introduction to the building blocks of Internet of Things 3. Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks 4. Introduction to core technologies- Sensors, Communication and Data Networks	
6	Course Outcomes	After completion of this course students will be able to: CO1: Able to illustrate key components of IoT and compare it with M2M CO2:. Able to explain generic network model as well as EPA model CO3: Able to analyse various IoT devices and their functionality CO4: Able to justify use of IoT in Industry CO5: Able to identify Key application areas CO6: Able to justify role of IoT in providing solution to various problems	
7	Course Description	IoT has become a game changer in the new economy where the customers are looking for integrated value & the IoT perspective in thinking and building solutions.	
8	Outline syllabus		CO Mapping
	Unit 1	**Basics Internet of things**	
	A	Overview with application examples	CO1,CO6
	B	Design Principles for connected devices	CO1
	C	Physical &logical Design, M2M Communication	CO1
	Unit 2	**Basic Topologies & Network Topologies**	
	A	LAN Topologies; IIoT,physical networking	CO2
	B	OSI model: significance, scope, functions of all layers; IEC's four layers EPA model: significance, functions of all layers.	CO2

	C	Router internals, common router architecture			CO2
	Unit 3	**IoT Devices and Networks**			
	A	Protocol stack, Physical layer, data link layer (Frame Format and MAC)			CO3
	B	Cloud connectivity, User interface, web app versus mobile app			CO3
	C	IoT devices-EV26,AR01,FMB920,MCK01,MCK05			CO3
	Unit 4	**Industrial IIoT**			
	A	Zigbee: Special features, data rates, Comparison of Zigbee with Wi-Fi and Bluetooth			CO4
	B	Sensor technologies and sensor applications			CO4
	C	IIoT application examples, IIoT future trends			CO4, CO6
	Unit 5	**Illustrative application Scenarios & concepts**			
	A	Smart Waste management, Smart energy conservation			CO5,CO6
	B	Smart Urban planning, Sustainable urban Environment, Smart Medication & emergency handling			CO5, CO6
	C	Smart product management, Home automation			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1. E-book-Designing of Internet of things by- Adrian McEwen, Hakim Cassimally, Wiley 2. *Internet of Things by-A Bahga &Vijay Madisetti,University Press* *https://in.coursera.org/learn/industrial-internet-of-things*			

School: SSET		**Batch : 2023-2025**
Programme: M. Tech.		**Current Academic Year: 2023-2024**
Branch: EEE		**Semester: I/II**
1	Course Code	MPS131
2	Course Title	Restructured Power System
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Department Elective
5	Course Objective	This course is designed to overview of planning and regulatory structure of power system
6	Course Outcomes	After completion of the course, the student will be able to **CO1:** Understand the need of restructuring of power system **CO2:** Acquire knowledge of basic concepts of economics and applied them to solve practical applications through numerical analysis. **CO3:** Grasp the knowledge of various market models, levels of competition exist among these models and features of electricity as a commodity. **CO4:** Acquire the knowledge, importance, effects and classification of Congestion Management methods **CO5:** Gain the information about various ancillary services. **CO6:** Familiar with different pricing mechanism of electric energy and trading of power under deregulated environment.
7	Course Description	The restructuring of power industry has changed the way of operation of the power system. Along with the secure and reliable operation of power systems, the economic efficiency has become an equally important consideration. Unlike the knowledge of conventional operation of power system, understanding the restructured power system require basic knowledge of electrical engineering, power systems and also the economics. This course is intended to provide a comprehensive treatment toward understanding the new decisions associated with the operation of power systems.

8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to restructuring of power industry**	
	A	Need and conditions for deregulation. Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements.	CO1,CO6
	B	Review of Concepts marginal cost of generation, least-cost operation, incremental cost of generation	CO1
	C	Power System Operation: Old vs. New.	CO1
	Unit 2	**Fundamentals of Economics and Market Models**	
	A	Electricity sector structures and Ownership /management, the forms of Ownership and management.	CO2,CO6

	B	Different structure model like Monopoly model, Purchasing agency model			CO2, CO6
	C	wholesale competition model, Retail competition model.			CO2,CO6
	Unit 3	**The Philosophy of Market Models**			
	A	Framework and methods for the analysis of Bilateral and pool markets,			CO3,
	B	LMP based markets, auction models and price formation			CO3
	C	price based unit commitment, country practices.			CO3,
	Unit 4	**Transmission Congestion Management and Locational Marginal Prices**			CO3
	A	Transmission network and market power			CO4
	B	Power wheeling transactions and marginal costing, transmission costing.			CO4
	C	Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices			CO4
	Unit 5	**Ancillary Service Management:**			
	A	Ancillary Services and System Security in Deregulation			CO5
	B	Classifications and definitions, AS management in various markets- country practices.			CO5
	C	Technical, economic, & regulatory issues involved in the deregulation of the power industry.			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book*	Hingorani N. G. and Gyugi L., “Understanding FACTS: concepts and technology of Flexible AC Transmission systems”, Wiley IEEE Press, 1999			
	Other References	1.Power System Economics: Designing markets for electricity - S. Stoft 2.Power generation, operation and control, -J. Wood and B. F. Wollenberg 3.Operation of restructured power systems - K. Bhattacharya, M.H.J. Bollen and J.E. Daalder 4.Market operations in electric power systems - M. Shahidehpour, H. Yamin and Z. Li 5.Fundamentals of power system economics - S. Kirschen and G. Strbac 6.Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry - N. S. Rau 7.Competition and Choice in Electricity - Sally Hunt and Graham			

		Shuttleworth	

School: SSET		Batch : 2023-25	
Programme: M.Tech		**Current Academic Year: 2023-24**	
Branch:EEE		**Semester: I/II**	
1	Course Code	MPS132	
2	Course Title	Operation and Control of smart grid	
3	Credits	2	
4	Contact Hours (L-T-P)	2-0-0	
	Course Status	Elective	
5	Course Objective	To provide students with: 1. To integrate and optimize distributed energy resources to achieve a more efficient andreliable grid, 2. Enable active participation of consumers with more environmental constraints.	
6	Course Outcomes	After completion of this course students will be able to: CO1: Identify different tools and approaches to modelling a Smart Grid. CO2: Apply Optimal Power Flow (OPF) solutions to evaluate the performance of a power system with renewable energy sources. CO3: Analyze power system dynamics (frequency stability) to achieve activepower balance. CO3: To familiarize the students with modelling of smart grids components. CO5: Identify control-room technologies for system-wide remote monitoring, protection, and risk management of smart grid cyber security CO6: Able to design, implementation, evaluation and management of smartelectricity infrastructure.	
7	Course Description	Smart grid communications and control, covering several special topics in the field of smart grid including advanced metering infrastructures, demand response, distributed storage, vehicle-to-grid systems, wide area measurement, smart grid cyber security, etc	
8	Outline syllabus		CO Mapping
	Unit 1	**Modeling of Smart Grids**	
	A	Operating principles and models of smart gird components	CO1
	B	Key technologies for generation, networks, loads and their control capabilities decision-making tools	CO1
	C	Hardware, Software, Communication. Approaches to estimation, scheduling, management and Control of next generation smart grid	CO1
	Unit 2	**Smart Grid Communications**;.	

	A	Two-way Digital Communications Paradigm, Network Architectures			CO2
	B	IP-based Systems, Power Line Communications			CO3
	C	Advanced Metering Infrastructure,			CO2, CO6
	Unit 3	**Security and Privacy**			
	A	Cyber Security Challenges in Smart Grid,Load Altering Attacks			CO4
	B	False Data Injection Attacks, Defense Mechanisms			CO4
	C	Privacy Challenges Data handling functions; Bit functions			CO4, CO6
	Unit 4	**IoT for power systems**			
	A	Internet of things for electricity infrastructure and energy management.			CO5
	B	SCADA, Demand response, AMI, IoT aided smart grid,			CO5
	C	Big data for power system and introduction to data analytics.			CO5
	Unit 5	**High Performance Computing for Smart Grid Applications**			
	A	Local Area Network (LAN), House Area Network (HAN),			CO5
	B	Wide Area Network (WAN),			CO5, CO6
	C	CLOUD Computing to make Smart Grids smarter			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage,Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", John Wiley & sons inc,2015. 2. . James Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & sons Inc, IEEE press 2012			
	Other References	1. Fereidoon P. Sioshansi, "Smart Grid: Integrating Renewable, Distributed & Efficient Energy", AcademicPress, 2012. 2.ClarkW.Gellings, "The smart grid: Enabling energy efficiency and demand response", Fairmont Press Inc, 2009. H.K. Verma, SCADA, e-monograph at			

School: SSET		**2023-2025**	
Programme: M. Tech.		**Current Academic Year: 2023-2024**	
Branch: EEE		**Semester: I/II**	
1	Course Code	MIA119	
2	Course Title	Optimal Control	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Department Elective	
5	Course Objective	To provide students with: 1.Basic knowledge of theoretical foundations of optimal control. 2.Develop skills needed to design controllers using available optimal control theory.	
6	Course Outcomes	After completion of the course, the student will be able to CO1: Understand the basic concepts of system optimization and optimal control system CO2: Understand and apply the concept of calculus of variations for optimal control problems. CO3: Demonstrate concept of LQR Design and Dynamic programming techniques. CO4: Design dynamic compensator and Filters. CO5: Apply optimal control theory under constraints CO6: Use the standard algorithms for numerical solution of optimal control problems	
7	Course Description	This course introduces systematic approaches to the analysis of optimal control system.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Dynamic system optimization, ,	CO1
	B	Optimal system performance indices	CO1
	C	Finite and Infinite horizon problems.	CO1
	Unit 2	**Calculus of variations**	
	A	Calculus of variations	CO2
	B	Constrained and unconstrained minimization	CO2
	C	Euler equation, Hamiltonian	CO2
	Unit 3	**Dynamic Programming**	
	A	Optimality principle, Potryagin's principle	CO3
	B	Riccati Equation; Hamilton Jacobi Bellman (HJB),	CO3,CO6
	C	Regulator (LQR), constrained and unconstrained input.	CO3, CO6
	Unit 4	**Dynamic Compensator and Filters**	
	A	Linear quadratic Gaussian (LQG),	CO4
	B	State estimator	CO4
	C	Kalman filter, discrete and continuous-time	CO4
	Unit 5	**Constrained Optimal Control systems**	

	A	Constrained optimal control, TOC of a double integrator systems			CO5
	B	Fuel optimal control systems, Minimum fuel systems: LTI system, Energy- optimal control systems,			CO5, CO6
	C	optimal control system with state constraints			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book*	1.“Optimal Control Systems,”DesineniSubharam Naidu, CRC Press, 2003. 2. “Optimal Control,” F. L. Lewis, D. L. Varbie and V. L. Syramos, John Wiley,			
	Other References	1. D.S. Naidu, Optimal control systems, CRC Press, First edition, 2002. 2. Arturo Locatelli, Optimal control: An Introduction, Birkhauser Verlag, 2001. 3. S.H.Zak, Systems and Control, Indian Edition , Oxford University, 2003.			

School: SSET		**Batch : 2023-25**	
Programme: M.Tech		**Current Academic Year: 2032-24**	
Branch: EEE		**Semester: I/II**	
1	Course Code	MPP202	
2	Course Title	Advanced Power System Lab-II	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status		
5	Course Objective	To provide students with: 1. To allow students to practically verify several concepts and procedures learned in power system modelling and analysis. 2. To develop hands-on experience of how certain procedures of power system operation are carried out 3. To carry out system studies using state of the art power systems analysis software to assess system operation in steady state and under faulted conditions. 4.To promote teamwork among students and effective communication skills.	
6	Course Outcomes	After completion of this course students will be able to: CO1: Learn MATLAB fundamentals CO2: Simulation of Bus admittance impedance matrix CO3: Load flow analysis using Matlab CO4: Fault analysis using Matlab CO5: Analyse load frequency control and voltage control CO6 : Apply software for power system industry	
7	Course Description	This lab course includes ten experiments to study various aspects of power systems: load flow data preparation and system study; system analysis of symmetrical and unsymmetrical faults and state estimation.	
8	Outline syllabus		CO Mapping
	Unit 1	**Formation of Bus/admittance matrix**	
	A	Simulation of swing Equation using Simulink	CO1
	B	Formation of Z-bus matrix of a power system	CO1
	C	Formation of Ybus	CO1
	Unit 2	**Load Flow**	
	A	Formation of Ybus using Sparsity Technique	CO1
	B	Load flow study of a 3-phase power system using Gauss-Seidel	CO1
	C	Load flow study of a 3-phase power system using NR	CO1
	Unit 3	**Practical related to fault analysis**	
	A	Simulate single line to ground fault and to measure voltage and current at different locations	CO2

	B	Simulate line to line fault and to measure voltage and current at different locations.			CO2
	Unit 4	**Short Circuit Studies For Unbalanced Network**			
	A	Simulation of symmetrical fault			CO2
	B	Simulation of Unsymmetrical fault			CO2
	C	Simulation of symmetrical fault in presence of compensator			CO2
	Unit 2	**Practical related to load frequency control and voltage control**			
	A	To design load frequency control model in MATLAB			CO3
	B	To connect shunt capacitor in most optimal location and to study improvement in voltage profile using MATLAB/PSCAD.			CO3
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	
	Text book/s*	Arrillaga J. and Arnold C.P., " Computer Analysis of Power Systems", John Wiley & Sons			
	Other References	3. Kusic G.L., "Computer Aided Power System Analysis", CRC Press. 4. Anderson P.M., "Analysis of Faulted Power Systems", Wiley-IEEE Press.			

School: SSET		**Batch: 2023-25**	
Programme: M. Tech.		**Current Academic Year: 2023-24**	
Branch: EEE		**Semester: I/II**	
1	Course Code	MPP201	
2	Course Title	Advanced Power System Lab-I	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status		
5	Course Objective	modern numerical techniques and analytical methods for dealing with and solving operation and protection related problems in electric power systems	
6	Course Outcomes	After the completion of course student will be able to CO1: Explore the concept of waveform distortion. CO2: Study the uncompensated transmission line CO3: Reactive power control using inductors. CO4: Reactive power control using capacitors. CO5: Simulate voltage source and current source inverters CO6: Simulation of multipulse converters.	
7	Course Description	This course aims to convince the student that constancy of frequency and voltage are the primary health indicator of the power system for maintaining the real and reactive power balance in systems. The concepts of economic load dispatch and unit commitment are also given in the course. The concept of close coordination between thermal and hydro power plant to meet the load demand has been included in the course.	
8			
	Unit 1	**Practical related to distortion in voltage and current waveform**	
	A	Introduction to Mat-lab Programming and Simulink.	CO1
	B	To demonstrate the voltage and current distortions experimentally.	CO1
	C	To study single phase fully controlled bridge rectifiers with resistive and inductive loads	CO1
	Unit 2	**Practical related to Transmission line Compensation**	
	A	Simulation of uncompensated Transmission line.	CO2
		To study the voltage sag due to starting of large induction motor	CO2
	B	Simulation of series compensated Transmission line.	CO4
	Unit 3	**Practical related to Transmission line shunt compensation**	
	A	Simulation of Shunt compensated Transmission line.	CO3
	B	Simulation of TCR Compensated Transmission line.	CO3
	C	Study of harmonics in TCR Compensated Transmission line.	CO3
	Unit 4	**Practical related to Transmission line Series Compensation**	
	A	Simulation of TSC Compensated Transmission line	CO4
	B	Simulation of single phase VSI	CO5
	C	Simulation of single-phase CSI	CO5

	Unit 5	**Practical related to Multipulse Converters**			
	A	Simulation and study of 6-Pulse Converter.			CO6
	B	Simulation and study of 12-Pulse Converter.			CO6
	C	Simulation and study of 18-Pulse Converter.			CO6
	Mode of examination	Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		25%	25%	50%	
	Text book/s*	1.Allen. J. Wood and Bruce F. Wollenberg, “Power Generation, Operation and Control”,John Wiley & Sons, Inc., 2003.			
	Other References	1. P.Kundur, “Power System Stability and Control”MC Craw Hill Publisher, USA, 1994. 2. Olle.I.Elgerd, “Electric Energy Systems Theory An Introduction” Tata McGraw Hill Publishing Company Ltd. New Delhi, Second Edition 2003			

School: SSET		**Batch : 2023-2025**
Programme: M.Tech		**Current Academic Year: 2023-2024**
Branch: EEE		**Semester: I/II**
1	Course Code	MPS125
2	Course Title	Electrical Drives
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Departmental Elective
5	Course Objective	To provide students with: 1. Introduction to different types of drives and applications in various industries. 2. To know the characteristics of various motors and loads. 3. To understand the modes of operation of a drive in various applications 4. To enable the students identify the need and choice for various drives. 5. To acquire the knowledge of different speed control methods in a.c motors
6	Course Outcomes	After the completion of course student will be able to CO1: Understand the characteristics of dc motors and induction motors. CO2: Understand the principles of speed-control of dc motors and induction motors. CO3: Understand the power electronic converters used for dc motor and induction motor speed control CO4: Acquire the knowledge about operation of dc motor speed control using converters and choppers CO5: Identify the use of drives in industrial applications CO6: Apply speed control methods to dc and ac motors
7	Course Description	This course introduces the concept of control of electric motors for various types of mechanical loads. DC motor control (both steady state and dynamic), and steady state torque and speed control of ac motors are emphasized.

8	Outline syllabus		CO Mapping
	Unit 1	**DC motor characteristics**	
	A	Review of emf and torque equations of DC machine, review of torque-speed characteristics of separately excited dc motor	CO1
	B	change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point,	CO1

	C	armature voltage control for varying motor speed, flux weakening for high speed operation	CO1
	Unit 2	**Chopper fed DC drive**	
	A	Review of dc chopper and duty ratio control, chopper fed dc motor for speed control	CO2,CO6
	B	steady state operation of a chopper fed drive, armature current waveform and ripple,	CO2,CO6
	C	calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting	CO2.CO6
	Unit 3	**Multi-quadrant DC drive**	
	A	Review of motoring and generating modes operation of a separately excited dc machine	CO3
	B	four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers	CO3
	C	steady-state operation of multi-quadrant chopper fed dc drive, regenerative braking	CO3,C06
	Unit 4	**Closed-loop control of DC Drive**	
	A	Control structure of DC drive, inner current loop and outer speed loop,	CO4.CO6
	B	dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay	CO4,CO6
	C	plant transfer function, for controller design, current controller specification and design, speed controller specification and design.	CO4,CO6
	Unit 5	**Induction motor characteristics**	
	A	Review of induction motor equivalent circuit and torque-speed characteristic	CO5
	B	variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency	CO5,CO6
	C	Typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation.	CO5,CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25% / MTE: 25% / ETE: 50%	
	Text book/s*	1. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall, 1989. 2. R. Krishnan, "Electric Motor Drives: Modelling, Analysis and Control", Prentice Hall, 2001.	
	Other References	1. G. K. Dubey, "Fundamentals of Electrical Drives", CRC Press, 2002. 2. W. Leonhard, "Control of Electric Drives", Springer Science & Business Media, 2001.	

School: SSET		Batch : 2023-2025	
Programme: M.Tech		**Current Academic Year: 2023-2024**	
Branch: EEE		**Semester: I/II**	
1	Course Code	MPS122	
2	Course Title	Extra High Voltage Transmission	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Elective	
5	Course Objective	This course is designed to train the students to cater for the design and R&D requirements for the EHV AC and HVDC power lines.	
6	Course Outcomes	After the completion of course student will be able to CO1 : To introduce to the problems in EHV transmission and calculate line parameters of EHV transmission line. CO2: Methods of protection against overvoltages CO3: Design passive shunt and series compensation CO4: Design of substation. CO5: Analyze the advantages of HVDC system and classify the HVDC systems types. CO6: Design compensation and protection of EHV system.	
7	Course Description	Elicit the advantages of EHV AC transmission systems. Mould students to acquire knowledge about HVDC Transmission systems. This course gives idea about modern trends in HVDC Transmission and its application, Understand about the overvoltage and its effects on power system. Complete analysis of harmonics and basis of protection for HVDC Systems.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to EHV Transmission**	
	A	Problems of EHV transmission	CO1
	B	calculation of impedance and capacitance matrices of 3-phase transmission line	CO1
	C	Electrostatic and Electromagnetic field, calculation of corona current/loss, radio interference, audible noise interference	CO1
	Unit 2	**Computation and Protection against Over-Voltage**	
	A	Causes of over voltages	CO2, CO6
	B	Methods of protection against switching surges	CO2,CO6
	C	Means of protection against lightning surges	CO2.CO6
	Unit 3	**Series and Shunt Compensation**	
	A	Effect of series capacitors, location of series capacitors	CO3,CO6
	B	Sub-synchronous resonance in series-capacitor compensated transmission lines	CO3,CO6
	C	Shunt compensation- conventional devices, static VAR	CO3,CO6

		compensation: TCR-FC, TCR, TSC-TCR devices			
	Unit 4	**Design of Substations**			
	A	Types of substations, layout of substation			CO4
	B	bus bar arrangements, grounding system- types of grounding, design parameters			CO4
	C	designing a grounding grid, measurement of soil resistivity			CO4
	Unit 5	**HVDC Systems**			
	A	Types of HVDC systems			CO5
	B	Terminal equipment and their operations			CO5
	C	Dc link control and protection			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book*	Begamudre R.D., "Extra High Voltage Transmission Engineering", New Age International(P) Ltd, New Delhi, 2003			
	Other References	1. Kundur P., "Power System Stability and Control", 2nd Ed., Tata-McGraw Hill, New Delhi, 2008 2. Padiyar K.R., "HVDC Power Transmission Systems", New Age International, 2005			

School: SSET		**Batch : 2023-2025**	
Programme: M. Tech.		**Current Academic Year: 2023-2024**	
Branch: EEE		**Semester: I/II**	
1	Course Code	EEE 452	
2	Course Title	Wind and Solar Energy Systems	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Department Elective	
5	Course Objective	The objective of the courses is to develop in-depth knowledge for the following: To develop an understanding of India and world renewable energy scenario. To design a power electronic equipped stand-alone PV system. To design a standalone wind power system. To integrate a solar PV system and wind energy system from electrical grid.	
6	Course Outcomes	At the end of this course, students will demonstrate the ability to)1: Apply the fundamentals of physics for wind and solar power generation.)2: Appreciate the advancements in turbine technologies and topologies.)3: Integrate the power electronic interfaces for wind and solar generation.)4: Understand and Identify modern advancements in solar photovoltaics and the battery energy storage.)5: Understand and solve issues related to the grid-integration of solar and wind energy systems)6: Design various aspects of wind and solar power generation.	
7	Course Description	The course is designed to familiarize and train the student with the tools and techniques used to assess the solar energy and wind energy and its potential at any location across the globe, so that a student is able analyse a case quantitatively at the end of the term.	
8	Outline syllabus		CO Mapping
	Unit 1	**Physics of Wind Power**	
	A	History of wind power, Indian and Global statistics, Wind physics	CO1
	B	Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions	CO1,CO6
	C	Wind speed and power-cumulative distribution functions	CO1
	Unit 2	**Wind generator topologies**	
	A	Review of modern wind turbine technologies, Fixed and Variable speed wind turbines	CO2
	B	Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators	CO2
	C	Power electronics converters. Generator-Converter	CO2,CO3

		configurations, Converter Control			
	Unit 3	**The Solar Resource and Energy Storage Systems**			
	A	Introduction, solar radiation spectra, solar geometry			CO1, CO3
	B	Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability			CO1, CO3,CO6
	C	Impact of intermittent generation – Battery energy storage – solar thermal energy storage			CO1, CO3
	Unit 4	**Solar photovoltaic**			
	A	Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell PV module and array			CO4,CO6
	B	Power Electronic Converters for Solar Systems			CO4,CO6
	C	Various MPPT methods			CO4,CO6
	Unit 5	**Network Integration Issues**			
	A	Overview of grid code technical requirements, Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits			CO5
	B	Solar PV and wind farm behaviour during grid disturbances. Power quality issues. Power system interconnection experiences in the world.			CO4,CO2
	C	Hybrid and isolated operations of solar PV and wind systems			CO2,CO2
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	G. M. Masters, "Renewable and Efficient Electric Power Systems**",** John Wiley and Sons, 2004.			
	Other References	1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005. 2. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984. 3. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.			

School: SSET	Batch : 2023-2025
Programme: M. Tech.	**Current Academic Year: 2023-2024**
Branch: EEE	**Semester: I/II**

1	Course Code	ECE946	
2	Course Title	Biomedical Instrumentation	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Programme Elective	
5	Course Objective	1.Getting knowledge electronics engineering applications in Biomedical 2.Getting knowledge of interdisciplinary 3.Exploring ideas on biomedical electronics and instrumentation	
6	Course Outcomes	After successful completion of this course the student will be able to: CO1:Knowledge of biomedical of sensors and engineering analogies in human anatomy CO2: Knowledge of different techniques of instruments for recordingdiagnostic systems CO3: Knowledge of different techniques of instruments for patient monitoringsystems CO4: Knowledge of different techniques of instruments for imaging systems CO5: Knowledge of different techniques of instruments for therapeutic systems CO6:Identify, explain and judge patient safety issues related to biomedical instrumentation.	
7	Course Description	The Biomedical Instrumentation subject gives knowledge about electronics equipments which are used in medical field. It is also give details about how touse these equipments to diagnose the problems of human body. It is a theoretical subject and very interesting also. Since wehave lot of developmentin technologies, there are lots of developments inmedical field also. So, this subject leads you to become an entrepreneur in the field of biomedical equipments marketing or service or distribution.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to BMI and its sensors**	
	A	Brief description of human body; Engineering in human body	CO1,CO6
	B	Silver-silver chloride electrode; microelectrodes; Jellies andCreams	CO1,CO6
	C	Sensors and electrodes of BMI	CO1,CO6
	Unit 2	**Biomedical Recorder Systems**	

	A	Electrocardiograph; Vector cardiograph;			CO2,CO6
	B	Electroencephalograph; Electromyograph;			CO2,CO6
	C	Spirometry			CO2,CO6
	Unit 3	**Patient Monitoring Systems**			
	A	Cardiac Monitor; Heart rate and pulse monitor;			CO3,CO6
	B	BP & Temperature Monitor			CO3,CO6
	C	Respiration rate, blood flow measurement			CO3,CO6
	Unit 4	**Medical Imaging, Patient Care and Monitoring**			
	A	Diagnostic X-rays and CAT			CO4,CO6
	B	MRI			CO4,CO6
	C	Medical			CO4,CO6
	Unit 5	**Biomedical Therapeutic Equipment**			
	A	Pace makers; Defibrillators			CO5,CO6
	B	Ultrasonic therapy unit;			CO5,CO6
	C	Pain relief system			CO5,CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	Khandpur R. S., "Handbook on Biomedical Instrumentation", 2nd Ed., Tata McGraw-Hill, 2015- ISBN: 9781119068013			
	Other References	1. Cromwell L., Weibell F. J. and Pfeifer E. A., "Biomedical Instrumentation and Measurements", Prentice Hall of India, 2003 2. Geddes L. A. and Baker L. E., "Principles of Applied Biomedical Instrumentation", John Wiley & Sons,1989-ISBN:9780471608998			