Program and Course Structure

Department of Electrical and Electronics Engineering

M.Tech in Electrical and Electronics Engineering

Program Code: SET0407

2020-21

1. Standard Structure of the Program at University Level

1.1 Vision, Mission and Core Values of the University

Vision of the University

To serve the society by being a global University of higher learning in pursuit of academic excellence, innovation and nurturing entrepreneurship.

Mission of the University

1. Transformative educational experience
2. Enrichment by educational initiatives that encourage global outlook
3. Develop research, support disruptive innovations and accelerate entrepreneurship
4. Seeking beyond boundaries

Core Values

- Integrity
- Leadership
- Diversity
- Community

1.2 Vision and Mission of the School

Vision of the School

To become a globally acclaimed institution of higher learning in engineering and technology promoting excellence in research, innovation and entrepreneurship

Mission of the School

1. To impart quality education with strong industry & academic connectivity in the expanding fields of Engineering and Technology in a conductive and enriching learning environment.
2. To product technocrats equipped with technical & soft skills and experiential learning required to stay current with the modern tools in emerging technologies to fulfill professional responsibilities and uphold ethical values.
3. To inculcate a culture of interdisciplinary research, innovation and entrepreneurship to provide sustainable solutions to meet the growing challenges and societal needs.
4. To foster collaborative learning and to play adaptive leadership role in professional career and pursuit of higher education through effective mentoring and counseling.

1.2.1 Vision and Mission of the Department

Vision of the Department of Electrical and Electronics Engineering

To establish itself as an international acclaimed destination of academic excellence in the discipline of Electrical and Electronics Engineering, socially relevant interdisciplinary research, nurturing innovation and entrepreneurship culture.

Mission of the Department Electrical and Electronics Engineering

i) To produce knowledgeable and skilled professionals in the wide range of government, private and public sector in the field of power sector and automation.

ii) To provide conducive environment for research and development in the field of electrical and automation, that enhances the competitiveness of the graduates, for higher studies and finding sustainable solution for the society.

iii) To encourage students through effective mentoring and counselling to perform duties and responsibilities with human values in professional career and social life.

iv) To foster a culture for multi- and interdisciplinary research, innovations and entrepreneurship by promoting collaborations and tie-ups with industry and reputed research organization across the globe.

1.3 Programme Educational Objectives (PEO)

1.3.1 Writing Programme Educational Objectives (PEO)

The Educational Objectives of UG Program in Electrical and Electronics Engineering are:

PEO1: The Graduands will establish themselves with knowledge and technical skill to match the need of modern industries of power sector and automation.

PEO2 : Graduates will be motivated for research and higher education and support their entrepreneurial learning.

PEO3 : Graduates will demonstrate their the communication skills and critical reasoning skills to perform responsibilities ethically for the sustainable development of the society.

PEO4: The Graduands will be able to learn and adopt new technologies in a multi- and interdisciplinary work environment for innovative solutions for real world problems

1.3.2 Map PEOs with School Mission Statements:

No.	PEO statement	School missions			
		Mission statement I	Mission statement 2	Mission statement 3	Mission statement 4
I	**PEO1:** The Graduands will establish themselves with knowledge and technical skill to match the need of modern industries of power sector and automation.	3	2	2	3
2	**PEO2** : Graduates will be motivated for research and higher education and support their entrepreneurial learning.	2	3	3	2
3	**PEO3** : Graduates will demonstrate their the communication skills and critical reasoning skills to perform responsibilities ethically for the sustainable development of the society.	2	3	2	3
4	**PEO4**: The Graduands will be able to learn and adopt new technologies in a multi- and interdisciplinary work environment for innovative solutions for real world problems	2	3	2	2

1.3.2.1 Map PEOs with Department Mission Statements:

DEPARTMENT PEOs / DEPT OF EEE MISSION STATEMENTS	1. The Graduands will establish themselves with knowledge and technical skill to match the need of modern industries of power sector and automation.	2. Graduates will be motivated for research and higher education and support their entrepreneurial learning.	3. Graduates will demonstrate their the communication skills and critical reasoning skills to perform responsibilities ethically for the sustainable development of the society.	4. The Graduands will be able to learn and adopt new technologies in a multi- and interdisciplinary work environment for innovative solutions for real world problems.	
1. To produce knowledgeable and skilled professionals in the wide range of government, private and public sector in the field of power sector and automation	**3**	**3**	**2**	**3**	**11/12**
2. To provide conducive environment for research and development in the field of electrical and automation, that enhances the competitiveness of the graduates, for higher studies and finding sustainable solution for the society..	**2**	**3**	**2**	**3**	**10/12**
3 To encourage students through effective mentoring and counselling to perform duties and responsibilities with human values in professional career and social life.	**2**	**2**	**3**	**3**	**10/12**
4: To foster a culture for multi- and interdisciplinary research, innovations and entrepreneurship by promoting collaborations and tie-ups with industry and reputed research organization across the globe.	**2**	**2**	**2**	**3**	**9/12**
	9/12	**10/12**	**9/12**	**12/12**	**83.3%**

1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)

1.3.3 Program Outcomes (PO's)

PO1: **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6: **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO7: **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO8: **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSOs for M.Tech in EEE

PSO1: To be able to critically investigate complex power system scenarios and arrive at possible solutions, by applying the acquired theoretical and practical knowledge.

PSO2 : To be able to identify optimal solutions for improvising power transfer capability, enhancing power quality and reliability.

PSO4: To be able to implement multidisciplinary knowledge, so as provide solutions to automation across various industries.

PSO3: To be able to integrate automation products from different manufacturers based on common standards.

1.3.4 Mapping of Program Outcome Vs Program Educational Objectives

Mapping	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	2	2	1	-	1
PO2	-	3	-	-	1
PO3	3	3	2	2	3
PO4	3	2	2	1	1
PO5	2	3	1	-	2
PO6	2	1	1	3	1
PO7	-	1	2	3	3
PO8	-	2	-	-	2
PSO1	3	2	-	1	-
PSO2	3	2	-	2	-
PSO3	3	2	-	1	-
PSO4	3	2	-	1	-

1. Slight (Low) ***2. Moderate (Medium)*** ***3.Substantial(high)***

M.Tech in Electrical and Electronics Engineering

COURSE STRUCTURE

Department of Electrical and Electronics Engineering M.TECH in Electrical and Electronics Engineering																
Course Structure for batches admitted in session 2019-21 and onwards																
Semester	**Courses**								**Courses**	**Labs**	**L**	**T**	**P**	**Weekly Contact**	**Credits**
I	Optimization Techniques in Engineering (3-1-0) 4	MEMS, Smart Sensors and WSN (3-0-2) 4	Elective 1 (3-0-2) 4	Elective 2 (3-1-0) 4	Elective 3 (3-0-0) 3				5	2	15	2	4	21	19
II	PLC and SCADA(3-0-2) 4	Elective 4 (3-1-0) 4	Elective5 (3-1-0)4	Elective 6 (3-0-2) 4	Elective 7 (3-0-0) 3	Elective 8 (3-0-0) 3	Community Connect (0-0-4) 2	Research Methodology (0-0-4) 2	6	4	18	2	12	32	26
III	Seminar (0-0-4) 2	Dissertation -1 (0-0-20) 10							0	2	0	0	24	24	12
IV	Dissertation -II (0-0-32) 16								0	1	0	0	32	32	16
TOTAL CREDITS															**73**

List Of Elective			
	With Specialization in **Power Systems**	With Specialization in **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	Biomedical Instrumentation	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	Robotics And Industrial Robots	Robotics And Industrial Robots
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	Distributed Generation Technology		

3.2 Program Outcome Vs Courses Mapping Table

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
MPS 114	2	2				2	1	3			1	
MPS 122	2	2					1				1	
MPS 104	2		1		3	2		2	1	2		1
MPS 152	3	2	1	1	2	-	-	-	-	1	1	2
MPS 117	3	3	2	3		2	3	2	1	1	1	3
MPS 123	2	2					3				1	
MPS 116	2	1	1	-	2	1	2	-	1	1	1	1.1
MPS 153	3	2	3						2	2	2	2
MPS 691	3	2	1	1	2	-	-	-	-	1	1	
MPS 693	3	3	2	3		2	3	2	1	1	1	
MPS 694	2	2	2	2					2	2	1	1
MIA111	2		1		3	2		2	1	2		2
MIA113	2	2					1				1	3
MIA112	2	2					3				1	
MIA114	3	2	1	1	2	-	-	-	-	1	1	-
MIA115	3	3	2	1	2	1	1	1	2	2	1	2
MIA117	2	2	2	2	2	2	1	-	3	3	2	3
MIA151	3	2	1	1	-	-	-	-	3	2	1	2
MIC151	2	1	3	2	2	1	1	1	2	2	3	2

SET		**Batch : 2019-21**
Program: M.Tech		**Current Academic Year: 2019-21**
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	• Discussing of basic components of actuators and mechatronics • Discussing of electronics and digital circuits concepts of the subject • Explaining concept of intelligent and smart system • Discussing of interfacing concepts of mechatronics systems • Giving case studies and exploring knowledge on designing
6	Course Outcomes	CO 1: 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
7	Course Description	The field of mechatronics has braddened the scope of the traditional field of elctromechanics. The subject is made to know modern trends on mechatronics system, hybrid of different engineerings, stand alone mechatronics systems.

8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Definitions: Mechatronics & actuator; Overview of sensors, current & voltage sources; Grounding	CO1
	B	Solenoids, relays, electrical motors for actuators	CO1
	C	Basics of open loop and closed loop systems , block diagram of mechatronics system ; Scope of the course	CO1
	Unit 2	**Overview of Analog and Digital Electronics**	CO2
	A	Active electronic devices for mechatroics, basics of operation amplifiers and instrumentation amplifiers	
	B	Display systems, measurement systems, testing and calibration	CO2
	C	Combination logic and logic classes; Flip-flops and their applications; Microcontroller concepts	CO2
	Unit 3	**Smart and Intelligent Actuators**	
	A	Definitions: Smart and intelligent actuators; Architecture and operation of smart actuator	CO3
	B	Intelligent actuator without feedback sensor in detail	CO3
	C	Intelligent actuator with feedback sensor in detail	CO3
	Unit 4	**Mechanical-Electronic Interfacing**	
	A	Concept of three-state (tri-state) outputs; Interfacing of pushbutton, keyboard and sensors	CO4

	B	Interfacing of relays, solenoids, DC, AC motors and special motors to microcontroller	CO4
	C	Selecting of motor for actuators	CO4
	Unit 5	**Case studies & Design Exercise**	
	A	Case study 1: Mechatronic design of a coin counter; Case study	CO5
	B	Case study 2: Mechatronics for conveyor based material handling system	CO5
	C	Design exercise on mechatronic system	CO5
	Mode of examination	Theory	
	Weightage Distribution	CA / MTE / ETE 30% / 20% / 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	

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO113.1	3	1	1	-	1	-	-	1	3	3	-	3
CO113.2	2	3	2	3	-	2	1	1	3	3	2	3
CO113.3	2	1	3	3	2	3	1	2	3	2	1	2
CO113.4	1	2	1	-	2	1	-	1	3	2	2	2
CO113.5	2	1	3	1	-	2	-	2	3	2	-	2

School: SET		**Batch : 2019-21**	
Program: M.Tech		**Current Academic Year: 2019-21**	
Branch: EEE/EE		**Semester: 1**	
1	Course Code	MIA112	
2	Course Title	**MEMS, Smart Sensors and WSN**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Compulsory /Elective/Open Elective	
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	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 applicable to MEMS and their fabrication CO3: To be able to select and apply the MEMS and smart sensors to different applications. CO4: To understand principles of wireless sensor networks and differentiate among various wireless network protocols . CO5: To apply principles of WSN in various industrial, environmental and societal applications.	
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, actuators and signal conditioners	CO1
	B	Definition, working principle and construction of MEMS	CO1
	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	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	CO3

		MEMS based smart acceleration and pressure sensors			
	B	Principle, characteristics and constructional details of a smart temperature sensor			CO3
	C	Principle, characteristics and constructional details of a smart humidity sensor			CO3
	Unit 4	**Wireless Sensor Network (WSN)**			
	A	Need and advantages of WSN, Network topologies; seven-layer OSI model of communication system			CO4
	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			CO4
	C	Sensor and actuator network (SAN) - homogeneous and heterogeneous SAN			CO4
	Unit 5	**WSN Applications in Industry**			
	A	Spectrum of applications; Case studies on WSN application: Environment monitoring			CO5
	B	Condition monitoring - Structural health and Equipment health monitoring			CO5
	C	Greenhouse monitoring and control			CO5
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	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.			

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO112.1	3	1	-	2	1	-	-	1	2	3	-	-
CO112.2	3	1	-	2	1	-	-	2	2	3	-	-
CO112.3	1	2	3	2	2	1	-	2	3	-	-	1
CO112.4	3	1	-	2	1	-	-	1	2	3	-	-
CO112.5	1	2	3	2	2	1	-	2	3	-	2	1

School: SET		**Batch : 2019-21**	
Program: M.Tech		**Current Academic Year: 2019-21**	
Branch: EEE/EE		**Semester: 1**	
1	Course Code	MIA117	
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 intelligent controller	
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 types and advanced control concepts of cascaded and feed forward controls. CO 3design, develop and operate analog controllers, both electronic and pneumatic types. CO4: Design develop and operate computer based control systems. CO5Understand simulate and design artificial intelligence based control system.	
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-common nonlinearities (saturation, dead-zone, relay, on-off nonlinearity, backlash, hysteresis	CO1
	Unit 2	**Controller Principles**	
	A	Process Characteristics; Control system parameters: error, 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;	CO2

		Composite Control modes: proportional-integral (PI), proportional-derivative (PD) and three mode controller (PID); Cascaded and feed-forward controls			
	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, Neurofuzzy control			CO5
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	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 soft computing," Wiley India Pvt. Limited. 2. S.Rajashekaran and G.A. Vijayalakshmi Pai, " Neural Nwtworks,Fuzzy logic, and Genetic Algorithms," PHI Pvt. Limited.			

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO117.1	3	2	1	1	1	-	-	-	-	-	2	-
CO117.2	3	2	1	1	1	-	-	-	-	-	2	-
CO117.3	2	2	3	2	2	-	-	-	3	3	1	1
CO117.4	2	2	3	2	2	-	-	-	3	3	2	2
CO117.5	2	2	3	2	2	-	-	-	3	3	3	3

School: SET		**Batch : 2019-21**	
Program: M.Tech		**Current Academic Year: 2019-21**	
Branch: I&A and I&C		**Semester: 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	Compulsory	
5	Course Objective	To provide the student with 1. Concepts so as to categorise various types of Signals and Systems. 2. İn-depth knowledge so that implemention of circuits related to linear applications of the opamp are acheivable. 3. Basic understanding for the implementatoion of active filters using opamp. 4. Strong foundation for designing of Digital Systems both FIR and IIR and analyses of systems using DFT and FFT.	
6	Course Outcomes	CO1: To categorise 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 and implement various types of digital filters. CO4: To do frequency analysis using DFT and FFT .	
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 opamp. Also the content elaborates the designing and implementation of digital filters along with DFT and FFT as the main frequency tool.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Introduction to Signals and Systems**	**CO1**
	A	Continuous-time and discrete-time signals and their mathematical representation, analog and digital signals, analog signal processing (ASP) and digital signal processing (DSP)	
	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	
	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.	
	Unit 2	**Linear Applications of Opamp**	**CO2**
	A	Operational amplifier: block diagram, equivalent circuit, ideal and practical operational amplifier; inverting and non-inverting amplifier circuits	
	B	Practical Integrator and Differentiator circuits,	
	C	Summing and differential amplifier circuits; Instrumentation amplifier	
	Unit 3	**Opamp based Filters**	**CO2**
	A	Passive and active filters, their comparison; frequency response of low- pass, high- pass ,band- pass, band- stop and notch filters and their use in instrumentation;	
	B	Active filters: Basic low- pass filter circuit , first and second order low- pass and high- pass Butterworth filters	
	C	Band- pass filter, Band reject (notch) filter, Concept of higher order filter realization	
	Unit 4	**Digital Filters**	**CO3**
	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.	
	B	Design of IIR Filters: Design by Approximation of Derivatives, Impulse Invariance and by Bilinear Transformation.	
	C	Direct form-1 and form-2 realizations, Cascade and Parallel realizations, recursive and non-recursive methods of realizations.	
	Unit 5	**Frequency Analysis**	**CO4**

	A	Digital Fourier transform (DFT),			
	B	DFT algorithm for frequency analysis			
	C	Fast Fourier transform (FFT), FFT algorithm for frequency analysis.			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	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,* *3..*			
	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 Integrated Circuits, PHI,2nd Edn.2006* *3.Jacob Milliman and Arvin Grabel, "Microelectronics" , 2nd Edition ,TMH, 2008* 1.			

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO101.1	3	1	1	-	-	-	-	-	-	-	-	-
CO101.2	2	2	3	3	2	-	-	-	2	2	-	2
CO101.3	2	3	3	2	3	-	-	-	3	2	-	2
CO101.4	3	3	3	3	2	-	-	-	-	1	-	1

Departmental Electives:

School:		Batch : 2019-21
Program:		**Current Academic Year: 2019-21**
Branch: EEE		**Semester:**
1	Course Code	MIC008
2	Course Title	Virtual Instrumentation
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Elective/Open Elective
5	Course Objective	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 Programming techniques like loops, arrays, clusters, plotting and Strings 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	CO1: Understand various models and areas of application of Virtual Instrumentation. CO2: Understand various components of LabVIEW required for the development of VI. CO3: Understand and apply various programming functions of LabVIEW like loops, arrays, clusters and file I/Os for building of simple Virtual instruments. CO4: Understand the concepts of Data acquisition hardware and software and to apply basic signal processing techniques available in LabVIEW. CO5: Able build VI for simulated and real time applications.
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**			CO1
	A	Graphical system design model - design model, prototype model, deployment model			
	B	Building blocks of VI; Virtual instrument versus traditional instrument, Hardware and software in VI			
	C	Graphical system Design using LabVIEW; Graphical programming and Textual programming			
	Unit 2	**Graphical system Design using LabVIEW**			CO2
	A	Advantages of LabVIEW; Components of VI Software - Front panel windows, Block diagram windows, Icon /connector pane			
	B	Creating and saving a VI; Toolbars, Palettes, Front panel controls and indicators, Block diagram – terminals, nodes, functions			
	C	Sub VIs, Express VIs and VIs, wires; Data types, Data flow program			
	Unit 3	**Programming Techniques**			**CO3,CO5**
	A	Modular Programming in Lab View; Building VI front panel and block diagram			
	B	Loops – for and while loops, Local and Global variables in LabVIEW, Arrays in LabVIEW,			
	C	Clusters in LabVIEW; Conversion between arrays and clusters, Plotting data in LabVIEW, Strings and File I/O in LabVIEW			
	Unit 4	**Data Acquisition and Signal Processing in LabVIEW**			**CO4**
	A	Transducers and Signal conditioning ,sampling and aliasing			
	B	Basics of DAQ hardware and software, DAQ modules and drivers for building virtual instruments			
	C	Fourier transforms; Power spectrum, Correlation methods; Windowing & filtering			
	Unit 5	**Advanced concepts in LabVIEW**			**CO5,CO3,CO4**
	A	Data Socket, TCP/IP VI’s synchronization			
	B	Serial interface buses - RS 232, RS485,USB			
	C	Concepts of real time systems; Image acquisition; Motion control			
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	2. Jovitha Jerome, “Virtual Instrumentation and LABVIEW”, PHI Learning			
	Other References	1. C.L. Clark, “LabVIEW Digital Signal Processing”, TMH Publishing Company. 3. Technical Manuals for DAQ Modules, Advantech and National Instruments 4. www.profhkverma.info: Chapter 2: Technologies/ Protocols for Wired Sensor Network			

		5. NI USER MANUAL http://www.ni.com/pdf/manuals/376445b.pdf 6. www.ni.com	

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO336.1	-	2	1	1	-	-	2	-	-	1	-	1
CO336.2	3	2	1	2	3	-	1	-	3	1	-	1
CO336.3	3	2	3	2	3	-	2	2	3	3	-	2
CO336.4	-	2	2	2	1	-	2	1	-	3	-	2
CO336.5	1	3	3	2	3	-	2	2	3	3	-	2

School: SET		**Batch : 2019-21**
Program: M.Tech		**Current Academic Year: 2019-21**
Branch: EEE/EE		**Semester: 1I**
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	Compulsory /Elective/Open Elective
5	Course Objective	To provide students with: 4. basic principles network communications and communication system models and it's seven layers. 5. In depth knowledge of wired and wireless network protocols. 6. With the concept of IoT, M2M and IIoT along with typical applications thereof.
6	Course Outcomes	CO1: To be able to understand the principles and types of data networks, especially those used in industry. CO2: have in-depth knowledge of industrial wired network protocols and their comparative 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 control and automation for industrial and societal applications. CO5: To be able to apply the concepts of IoT and design and develop IoT systems for industrial, societal, environmental and domestic applications.
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 IoT concepts 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 duplex and full duplex modes, MAC protocol, merits and limitations. **Modbus:** Modbus protocol stack, Modbus address space and object types, 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 industrial application	CO3
	B	Common Industrial Protocol (CIP)	CO3
	C	**Ethernet/IP:** Adaption of Common Industrial Protocol (CIP) to standard Ethernet, UDP, comparison between standard Ethernet 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 protocol and data transfer types	CO4
	B	Wireless network topologies	CO4
	C	**Comparison** of Zigbee with Wi-Fi and Bluetooth.	CO4
	Unit 5	**IoT and 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, M2M and IIoT; Modified OSI model for IoT/M2M/IIoT;	CO5
	C	Examples of applications of IoT, M2M and IIoT.	CO5
	Mode of examination	Theory/Jury/Practical/Viva	
	Weightage Distribution	CA: 30% · MTE: 20% · ETE: 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 System SCADA and Smart Grids", CRC Press, 2015. 3. Raj Kamal, "Internet of Things: Architecture and Design Principles", 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 Instrumentation Techniques", Prentice Hall, 2004. **4.** H.K. Verma, Sensor Networks, e-monograph at www.profhkverma.info, Chapter 2 – Wired Network Technologies/Protocols, Chapter 3 – Wireless Network Technologies/Protocols. 5. H.K. Verma, SCADA, e-monograph at www.profhkverma.info, Chapter 4: Network Technologies Deployed in SCADA Systems.	

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO7	PO10	PO12	PSO1	PSO2	PSO3	PSO4
CO116.1	3	1	-	-	2	-	-	2	2	1	-	1
CO116.2	3	2	3	2	2	-	-	2	2	2	-	2
CO116.3	3	2	3	2	2	-	-	2	2	2	-	2
CO116.4	3	2	3	2	2	2	-	2	2	2	-	2
CO116.5	3	2	3	2	2	2	-	2	2	2	-	2

School: SET	**Batch : 2019-21**	
Program: M.Tech	**Current Academic Year: 2019-21**	
Branch:EEE	**Semester:II**	

1	Course Code		
2	Course Title	Robotics and Industrial Robots	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Elective /Compusory	
5	Course Objective	1.To understand the construction industrial robotics 2.To explore knowledge on selection of end-effectors of robotics 3.To get knowledge of electrical drive systems of industrial robotics 4.To know types of sensors of industrial robotics 5.To understand of electrical and electronics interfacings 6.To study about applications of industrial robots	
6	Course Outcomes	CO1: Basic construction of robot and robotics components CO2: Understanding interfacing & building techniques of robots CO3: Knowing different types of actuators of robotics CO4: Getting knowledge of robotics sensors and transducers CO5: Developing interfacing circuits for robotics applications	
7	Course Description	This course gives coverage of robotics components, architecture, and electronics interfacing circuits knowledge. Students can also practice programming of robotics using embedded C on open source software after going through this subject. Finally students are able to do tailor-made projects on robotics engineering	
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 and their uses; Specifications of robots.	CO1
	C	Position representation; Forward and reverse transformation: 2 & 3 DOF	CO1
	Unit 2	**Robot End-Effectors, Robot Drives and Actuators**	
	A	Classification of end-effectors; Mechanical grippers, Magnetic grippers and vaccum grippers; Gripper force analysis.	CO2
	B	Functions of drive systems; Electrical drives: DC, BLDC motors, AC motors, stepper motor, piezoelectric actuators;	CO2,CO3
	C	Drive Mechanisms: rack and pinion, ball screws, gear trains and harmonic drive.	CO2
	Unit 3	**Sensors of Robotic System**	
	A	Uses of sensors in robotics; Shaft Encoders (linear and rotational);	CO4
	B	Proximity Sensors (inductive and capacitive); Tactile sensors;	CO4
	C	Basic block diagram of vision systems of robotic system.	CO4
	Unit 4	**Controlling Technologies of Industrial Robots**	

	A	Basics of PC interfacings			CO5
	B	Microcontroller interfacings			CO5
	C	Robot languages and classification; Robot software.			CO5
	Unit 5	**Industrial Robot Applications**			
	A	Material handling robots			CO6
	B	Welding Robots			CO6
	C	Assembling robots			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1.S.R. Deb and S. Deb, "Robotics Technology and Flexible Automation", Second edition, McGraw Hill, 2011.			
	Other References	2. Mikell P Groover et al., "Industrial Robotics", fifth print, McGraw Hill, Special Indian Edition, 2013			

Course Articulation Matrix

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1 115.1	2	2	3	2	-	-	-	2	1	2	1	2
CO2 115.2	2	3	3	2	3	1	1	3	2	2	2	2
CO3 115.3	3	3	2	2	3	1	1	3	3	3	3	2
CO4 115.4	3	2	2	3	2	1	-	2	2	3	2	2
CO5115.5	2	3	3	2	1	1	2	-	3	2	3	3

School: SET	**Batch : 2019-21**	
Program: M.Tech	**Current Academic Year: 2019-21**	
Branch: EEE/EE	**Semester: 1**	

1	Course Code	MIA117	
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 intelligent controller	
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 types and advanced control concepts of cascaded and feed forward controls. CO 3design, develop and operate analog controllers, both electronic and pneumatic types. CO4: Design develop and operate computer based control systems. CO5Understand simulate and design artificial intelligence based control system.	
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-common nonlinearities (saturation, dead-zone, relay, on-off nonlinearity, backlash, hysteresis	CO1
	Unit 2	**Controller Principles**	
	A	Process Characteristics; Control system parameters: error, 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),	CO2

		proportional-derivative (PD) and three mode controller (PID); Cascaded and feed-forward controls			
	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, Neurofuzzy control			CO5
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	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 soft computing," Wiley India Pvt. Limited. 2. S.Rajashekaran and G.A. Vijayalakshmi Pai, " Neural Nwtworks,Fuzzy logic, and Genetic Algorithms," PHI Pvt. Limited.			

COURSE ARTICULATION MATRIX

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO117.1	3	2	1	1	1	-	-	-	-	-	2	-
CO117.2	3	2	1	1	1	-	-	-	-	-	2	-
CO117.3	2	2	3	2	2	-	-	-	3	3	1	1
CO117.4	2	2	3	2	2	-	-	-	3	3	2	2
CO117.5	2	2	3	2	2	-	-	-	3	3	3	3

School: SET		**Batch : 2019-21**	
Program: M.Tech		**Current Academic Year: 2019-21**	
Branch: EEE/EE		**Semester: 1**	
1	Course Code	MIA112	
2	Course Title	**MEMS, Smart Sensors and WSN**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Compulsory /Elective/Open Elective	
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	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 applicable to MEMS and their fabrication CO3: To be able to select and apply the MEMS and smart sensors to different applications. CO4: To understand principles of wireless sensor networks and differentiate among various wireless network protocols . CO5: To apply principles of WSN in various industrial, environmental and societal applications.	
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, actuators and signal conditioners	CO1
	B	Definition, working principle and construction of MEMS	CO1
	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	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	CO3

		MEMS based smart acceleration and pressure sensors			
	B	Principle, characteristics and constructional details of a smart temperature sensor			CO3
	C	Principle, characteristics and constructional details of a smart humidity sensor			CO3
	Unit 4	**Wireless Sensor Network (WSN)**			
	A	Need and advantages of WSN, Network topologies; seven-layer OSI model of communication system			CO4
	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			CO4
	C	Sensor and actuator network (SAN) - homogeneous and heterogeneous SAN			CO4
	Unit 5	**WSN Applications in Industry**			
	A	Spectrum of applications; Case studies on WSN application: Environment monitoring			CO5
	B	Condition monitoring - Structural health and Equipment health monitoring			CO5
	C	Greenhouse monitoring and control			CO5
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	4 D. Patranabis, "Sensors and Transducers", Prentice-Holl, 2nd Edition, 2003. 5 Randy Frank, "Understanding Smart Sensors", Artech House, 2nd Edition, 2000. 6 E.H. Callaway, "Wireless Sensor Networks : Architecture and Protocols"			
	Other References	3. 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. 4. 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.			

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO112.1	3	1	-	2	1	-	-	1	2	3	-	-
CO112.2	3	1	-	2	1	-	-	2	2	3	-	-
CO112.3	1	2	3	2	2	1	-	2	3	-	-	1
CO112.4	3	1	-	2	1	-	-	1	2	3	-	-
CO112.5	1	2	3	2	2	1	-	2	3	-	2	1

School: SET	**Batch : 2019-21**	
Program: M.Tech	**Current Academic Year: 2019-21**	
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	• Discussing of basic components of actuators and mechatronics • Discussing of electronics and digital circuits concepts of the subject • Explaining concept of intelligent and smart system • Discussing of interfacing concepts of mechatronics systems • Giving case studies and exploring knowledge on designing	
6	Course Outcomes	CO 1: 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	
7	Course Description	The field of mechatronics has braddened the scope of the traditional field of elctromechanics. The subject is made to know modern trends on mechatronics system, hybrid of different engineerings, stand alone mechatronics systems.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Definitions: Mechatronics & actuator; Overview of sensors, current & voltage sources; Grounding	CO1
	B	Solenoids, relays, electrical motors for actuators	CO1
	C	Basics of open loop and closed loop systems , block diagram of mechatronics system ; Scope of the course	CO1
	Unit 2	**Overview of Analog and Digital Electronics**	CO2
	A	Active electronic devices for mechatroics, basics of operation amplifiers and instrumentation amplifiers	
	B	Display systems, measurement systems, testing and calibration	CO2
	C	Combination logic and logic classes; Flip-flops and their applications; Microcontroller concepts	CO2
	Unit 3	**Smart and Intelligent Actuators**	
	A	Definitions: Smart and intelligent actuators; Architecture and operation of smart actuator	CO3
	B	Intelligent actuator without feedback sensor in detail	CO3
	C	Intelligent actuator with feedback sensor in detail	CO3
	Unit 4	**Mechanical-Electronic Interfacing**	
	A	Concept of three-state (tri-state) outputs; Interfacing of pushbutton, keyboard and sensors	CO4

	B	Interfacing of relays, solenoids, DC, AC motors and special motors to microcontroller			CO4
	C	Selecting of motor for actuators			CO4
	Unit 5	**Case studies & Design Exercise**			
	A	Case study 1: Mechatronic design of a coin counter; Case study			CO5
	B	Case study 2: Mechatronics for conveyor based material handling system			CO5
	C	Design exercise on mechatronic system			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	David G, Alciatore et al., "Introduction to Mechatronics and Measurement Systems", Tata McGraw Hill, 2003			
	Other References	3. W.Bolton, "Mechatronics ", Pearson Education, 2005 4. Godfrey C. Onwubolu, "Mechatronics", Elsevier, 2005			

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO113.1	3	1	1	-	1	-	-	1	3	3	-	3
CO113.2	2	3	2	3	-	2	2	1	3	3	2	3
CO113.3	2	1	3	3	2	3	3	2	3	2	1	2
CO113.4	1	2	1	-	2	1	1	1	3	2	2	2
CO113.5	2	1	3	1	-	2	-	2	3	2	-	2

School: SET	**Batch : 2019-21**	
Program: B.Tech	**Current Academic Year: 2019-21**	
Branch:EEE/EE/ECE	**Semester: 2**	

1	Course Code	**EEE331**	
2	Course Title	**PLC and SCADA**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	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	The students should be able to CO1: understand the concepts of computer based Industrial Control, including PLC, DCS and SCADA. CO2: understand hardware of PLC and ladder programming for PLC. CO3: use various PLC functions and develop PLC programs for industrial control and automation applications. CO4: understand the purpose, layout, components and functions of SCADA systems and use the knowledge for the operation of SCADA systems in Industry CO5.design SCADA system including layout, communication system and software.	
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, PLC and SCADA systems.	
8	Outline syllabus		CO Mapping
	Unit 1	**Computer Based Industrial Control**	
	A	Microprocessor/microcontroller based industrial controller: concept and configuration	CO1
	B	Computer based industrial controller: concept and configuration	CO1
	C	Introduction to direct digital control (DDC), distributed control system (DCS) and supervisory control and data acquisition (SCADA)	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
	Unit 3	**PLC Functions**	
	A	Registers: holding, input and output registers; Timers and timer	CO4

		functions; Counters and counter functions			
	B	Data handling functions; Bit functions;			CO4
	C	Advanced functions; PLC programming using various functions			CO4
	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 Design**			
	A	Master Terminal Unit (MTU): functions, single processor and multiprocessor MTU, single and dual computer configurations of MTU; Remote Terminal Unit (RTU): functions, architecture / layout; RTU programming			CO5
	B	MTU-RTU communication and RTU-field device communication			CO5
	C	Design of SCADA system : HARDWARE, Communication and Software.			CO5
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. J.W. Webb and R.A. Reis, Programmable 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, Programmable Logic Controllers, Pearson Edition 2. W. Boston, Programmable 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.			

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO336.1	3	3	-	1	-	-	-	-	2	1	-	1
CO336.2	3	3	-	1	2	-	-	-	2	1	2	1
CO336.3	3	3	-	1	2	-	-	-	2	3	2	1
CO336.4	3	3	-	1	-	-	-	-	2	1	-	1
CO336.5	2	2	3	3	3	-	-	-	2	3	2	1

School:		**Batch: 2019-21**		
Program: M Tech		**Current Academic Year: 2019-21**		
Branch: EEE I&A		**Semester:2**		
1	Course Code	EEP117		
2	Course Title	PLC and SCADA Lab		
3	Credits	1		
4	Contact Hours (L-T-P)	0-0-2		
	Course Status	Compulsory		
5	Course Objective	To equip students with the working knowledge about the PLC based process control and SCADA functions.		
6	Course Outcomes	CO1: To study and perform basic experiments on PLC. CO2: To perform process control using PLC. CO3: To perform motor control using PLC. CO4: To implement basic SCADA functions. CO5: To implement advanced SCADA functions		
7	Course Description	The contents of this course covers the implementation of basic and advanced functions of PLC and SCADA and their applications in controls.		
8	Outline syllabus			CO Mapping
	Unit 1	**PLC based basic experiments**		
	A	1.To study and use of NO and NC bit 2.To study and use of S (Set) and R (Reset) bit		CO1
	B	1.To study and use of Timer instruction 2.To study and use of Cumulative timer instruction		CO1
	C	1.To study and use of Counter instruction 2. To study logic gates in PLC.		CO1
	Unit 2	**PLC based process control**		
	A	Water Level Control using PLC		CO2
	B	Conveyor Belt Control Module using PLC		CO2
	C	Traffic control using PLC		
	Unit 3	**PLC based Motor Control**		
	A-B	Ac motor speed control module using PLC.		CO3
	C	Dc motor speed control module using PLC		CO3
	Unit 4	**Basic SCADA functions**		
	A	Parameter reading of PLC in SCADA.		CO4
	B-C	Alarm annunciation using SCADA.		CO4
	Unit 5	**Advanced SCADA functions**		
	A	SCADA communication with PLC		CO5
	B	Trend Monitoring on SCADA		CO4
	C	Reporting on SCADA		
	Mode of examination	Practical & Viva		
	Weightage Distribution	CA	MTE	ETE
		60%	0%	40%
	Text book/s*			
	Other References	Refer lab manuals		

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO2
CO1	2	2	2	1	-	2	-	2	2	1	2	1
CO2	3	2	1	2	2	3	-	2	2	3	2	3
CO3	3	1	2	1	1	2	-	2	2	2	2	2
CO4	2	2	2	1	2	1	-	1	3	2	2	2
CO5	3	1	2	1	1	2	-	2	2	2	2	2

School: SET	**Batch : 2019-21**	
Program: M.Tech	**Current Academic Year: 2019-21**	
Branch:EEE	**Semester: II**	

1	Course Code	MIA 115	
2	Course Title	Robotics and Industrial Robots	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Compulsory/Elective	
5	Course Objective	1.To understand the construction industrial robotics 2.To explore knowledge on selection of end-effectors of robotics 3.To get knowledge of electrical drive systems of industrial robotics 4.To know types of sensors of industrial robotics 5.To understand of electrical and electronics interfacings 6.To study about applications of industrial robots	
6	Course Outcomes	CO1: Basic construction of robot and robotics components CO2: Understanding interfacing & building techniques of robots CO3: Knowing different types of actuators of robotics CO4: Getting knowledge of robotics sensors and transducers CO5: Developing interfacing circuits for robotics applications	
7	Course Description	This course gives coverage of robotics components, architecture, and electronics interfacing circuits knowledge. Students can also practice programming of robotics using embedded C on open source software after going through this subject. Finally students are able to do tailor-made projects on robotics engineering	
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 and their uses; Specifications of robots.	CO1
	C	Position representation; Forward and reverse transformation: 2 & 3 DOF	CO1
	Unit 2	**Robot End-Effectors, Robot Drives and Actuators**	
	A	Classification of end-effectors; Mechanical grippers, Magnetic grippers and vaccum grippers; Gripper force analysis.	CO2
	B	Functions of drive systems; Electrical drives: DC, BLDC motors, AC motors, stepper motor, piezoelectric actuators;	CO2,CO3
	C	Drive Mechanisms: rack and pinion, ball screws, gear trains and harmonic drive.	CO2
	Unit 3	**Sensors of Robotic System**	
	A	Uses of sensors in robotics; Shaft Encoders (linear and rotational);	CO4
	B	Proximity Sensors (inductive and capacitive); Tactile sensors;	CO4
	C	Basic block diagram of vision systems of robotic system.	CO4

	Unit 4	**Controlling Technologies of Industrial Robots**			
	A	Basics of PC interfacings			CO5
	B	Microcontroller interfacings			CO5
	C	Robot languages and classification; Robot software.			CO5
	Unit 5	**Industrial Robot Applications**			
	A	Material handling robots			CO6
	B	Welding Robots			CO6
	C	Assembling robots			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1.S.R. Deb and S. Deb, "Robotics Technology and Flexible Automation", Second edition, McGraw Hill, 2011.			
	Other References	2. Mikell P Groover et al., "Industrial Robotics", fifth print, McGraw Hill, Special Indian Edition, 2013			

Course Articulation Matrix

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO 115.1	2	2	3	2	-	-	-	1	2	1	2
CO 115.2	2	3	3	2	3	1	1	2	2	2	2
CO 115.3	3	3	2	2	3	1	1	3	3	3	2
CO 115.4	3	2	2	3	2	1	-	2	3	2	2
CO 115.5	2	3	3	2	1	1	2	3	2	3	3

School: SET		**Batch : 2019-21**
Program: M.Tech		**Current Academic Year: 2019-21**
Branch: EEE/EE		**Semester: 1I**
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	Compulsory /Elective/Open Elective
5	Course Objective	To provide students with: 4. basic principles network communications and communication system models and it's seven layers. 5. In depth knowledge of wired and wireless network protocols. 6. With the concept of IoT, M2M and IIoT along with typical applications thereof.
6	Course Outcomes	CO1: To be able to understand the principles and types of data networks, especially those used in industry. CO2: have in-depth knowledge of industrial wired network protocols and their comparative 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 control and automation for industrial and societal applications. CO5: To be able to apply the concepts of IoT and design and develop IoT systems for industrial, societal, environmental and domestic applications.
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 IoT concepts 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 duplex and full duplex modes, MAC protocol, merits and limitations. **Modbus:** Modbus protocol stack, Modbus address space and object types, 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 industrial application			CO3
	B	Common Industrial Protocol (CIP)			CO3
	C	**Ethernet/IP:** Adaption of Common Industrial Protocol (CIP) to standard Ethernet, UDP, comparison between standard Ethernet 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 protocol and data transfer types			CO4
	B	Wireless network topologies			CO4
	C	**Comparison** of Zigbee with Wi-Fi and Bluetooth.			CO4
	Unit 5	**IoT and 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, M2M and IIoT; Modified OSI model for IoT/M2M/IIoT;			CO5
	C	Examples of applications of IoT, M2M and IIoT.			CO5
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	4. William Stallings, "Data and Computer Communications", 8th Edition, Pearson Prentice Hall, 2007.			

		5. Mini S. Thomas and John D. McDonald, "Power System SCADA and Smart Grids", CRC Press, 2015. 6. Raj Kamal, "Internet of Things: Architecture and Design Principles", Mc Graw Hill Education, 2017.	
	Other References	7. David Bailey and Edwin Wright, "Practical SCADA for Industry", Newnes, 2009. 8. S.K. Singh, "Industrial Instrumentation and Control", Tata McGraw-Hill, 2003. 9. M.M.S. Anand, "Electronic Instruments and Instrumentation Techniques", Prentice Hall, 2004. **10.** H.K. Verma, Sensor Networks, e-monograph at www.profhkverma.info, Chapter 2 – Wired Network Technologies/Protocols, Chapter 3 – Wireless Network Technologies/Protocols. 11. H.K. Verma, SCADA, e-monograph at www.profhkverma.info, Chapter 4: Network Technologies Deployed in SCADA Systems.	

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO116.1	3	1	-	-	2	-	-	2	2	1	-	1
CO116.2	3	2	3	2	2	-	-	2	2	2	-	2
CO116.3	3	2	3	2	2	-	-	2	2	2	-	2
CO116.4	3	2	3	2	2	2	-	2	2	2	-	2
CO116.5	3	2	3	2	2	2	-	2	2	2	-	2

School:		Batch : 2019-21
Program:		**Current Academic Year: 2019-21**
Branch: EEE		**Semester:**
1	Course Code	MIC008
2	Course Title	Virtual Instrumentation
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Elective/Open Elective
5	Course Objective	9. Introduction to the various models of Virtual Instruments, their comparison with traditional instruments and major application areas of VI. 10. Introduction to basics of LabVIEW 11. VI Programming techniques like loops, arrays, clusters, plotting and Strings and files. 12. Basics of signal conditioning techniques along with DAQ hardware and software and various signal processing techniques available in LABVIEW. 13. Advanced concepts in LabVIEW with main concepts of real time applications in Image acquisition and Motion control. 14. Building of Virtual Instruments with various types of controls and indicators. 15. Configuring DAQ card and acquisition of real time signals from sources and sensors. 16. Simulate a signal in LabVIEW and generate a virtual source using DAQ cards.
6	Course Outcomes	CO1: Understand various models and areas of application of Virtual Instrumentation. CO2: Understand various components of LabVIEW required for the development of VI. CO3: Understand and apply various programming functions of LabVIEW like loops, arrays, clusters and file I/Os for building of simple Virtual instruments. CO4: Understand the concepts of Data acquisition hardware and software and to apply basic signal processing techniques available in LabVIEW. CO5: Able build VI for simulated and real time applications.
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**			CO1
	A	Graphical system design model - design model, prototype model, deployment model			
	B	Building blocks of VI; Virtual instrument versus traditional instrument, Hardware and software in VI			
	C	Graphical system Design using LabVIEW; Graphical programming and Textual programming			
	Unit 2	**Graphical system Design using LabVIEW**			CO2
	A	Advantages of LabVIEW; Components of VI Software - Front panel windows, Block diagram windows, Icon /connector pane			
	B	Creating and saving a VI; Toolbars, Palettes, Front panel controls and indicators, Block diagram – terminals, nodes, functions			
	C	Sub VIs, Express VIs and VIs, wires; Data types, Data flow program			
	Unit 3	**Programming Techniques**			**CO3,CO5**
	A	Modular Programming in Lab View; Building VI front panel and block diagram			
	B	Loops – for and while loops, Local and Global variables in LabVIEW, Arrays in LabVIEW,			
	C	Clusters in LabVIEW; Conversion between arrays and clusters, Plotting data in LabVIEW, Strings and File I/O in LabVIEW			
	Unit 4	**Data Acquisition and Signal Processing in LabVIEW**			**CO4**
	A	Transducers and Signal conditioning ,sampling and aliasing			
	B	Basics of DAQ hardware and software, DAQ modules and drivers for building virtual instruments			
	C	Fourier transforms; Power spectrum, Correlation methods; Windowing & filtering			
	Unit 5	**Advanced concepts in LabVIEW**			**CO5,CO3,CO4**
	A	Data Socket, TCP/IP VI's synchronization			
	B	Serial interface buses - RS 232, RS485,USB			
	C	Concepts of real time systems; Image acquisition; Motion control			
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	7. Jovitha Jerome, "Virtual Instrumentation and LABVIEW", PHI Learning			
	Other References	1. C.L. Clark, "LabVIEW Digital Signal Processing", TMH Publishing Company. 8. Technical Manuals for DAQ Modules, Advantech			

		and National Instruments 9. www.profhkverma.info: Chapter 2: Technologies/ Protocols for Wired Sensor Network 10. NI USER MANUAL http://www.ni.com/pdf/manuals/376445b.pdf 11. www.ni.com	

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO336.1	-	2	1	1	-	-	2	-	-	1	-	1
CO336.2	3	2	1	2	3	-	1	-	3	1	-	1
CO336.3	3	2	3	2	3	-	2	2	3	3	-	2
CO336.4	-	2	2	2	1	-	2	1	-	3	-	2
CO336.5	1	3	3	2	3	-	2	2	3	3	-	2

School: SET		**Batch : 2019-21**
Program: M.Tech		**Current Academic Year: 2019-21**
Branch: I&A and I&C		**Semester: I**
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	Compulsory
5	Course Objective	To provide the student with 5. Concepts so as to categorise various types of Signals and Systems. 6. İn-depth knowledge so that implemention of circuits related to linear applications of the opamp are acheivable. 7. Basic understanding for the implementatoion of active filters using opamp. 8. Strong foundation for designing of Digital Systems both FIR and IIR and analyses of systems using DFT and FFT.
6	Course Outcomes	CO1: To categorise 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 and implement various types of digital filters. CO4: To do frequency analysis using DFT and FFT .
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 opamp. Also the content elaborates the designing and implementation of digital filters along with DFT and FFT as the main frequency tool.

8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Introduction to Signals and Systems**	**CO1**
	A	Continuous-time and discrete-time signals and their mathematical representation, analog and digital signals, analog signal processing (ASP) and digital signal processing (DSP)	
	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	
	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.	
	Unit 2	**Linear Applications of Opamp**	**CO2**
	A	Operational amplifier: block diagram, equivalent circuit, ideal and practical operational amplifier; inverting and non-inverting amplifier circuits	
	B	Practical Integrator and Differentiator circuits,	
	C	Summing and differential amplifier circuits; Instrumentation amplifier	
	Unit 3	**Opamp based Filters**	**CO2**
	A	Passive and active filters, their comparison; frequency response of low- pass, high- pass ,band- pass, band- stop and notch filters and their use in instrumentation;	
	B	Active filters: Basic low- pass filter circuit , first and second order low- pass and high- pass Butterworth filters	
	C	Band- pass filter, Band reject (notch) filter, Concept of higher order filter realization	
	Unit 4	**Digital Filters**	**CO3**
	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.	
	B	Design of IIR Filters: Design by Approximation of Derivatives, Impulse Invariance and by Bilinear Transformation.	
	C	Direct form-1 and form-2 realizations, Cascade and Parallel realizations, recursive and non-recursive methods of realizations.	
	Unit 5	**Frequency Analysis**	**CO4**

<table>
<tr><td></td><td>A</td><td colspan="3">Digital Fourier transform (DFT),</td><td></td></tr>
<tr><td></td><td>B</td><td colspan="3">DFT algorithm for frequency analysis</td><td></td></tr>
<tr><td></td><td>C</td><td colspan="3">Fast Fourier transform (FFT), FFT algorithm for frequency analysis.</td><td></td></tr>
<tr><td></td><td>Mode of examination</td><td colspan="3">Theory</td><td></td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Weightage Distribution</td><td>CA</td><td>MTE</td><td>ETE</td><td></td></tr>
<tr><td>30%</td><td>20%</td><td>50%</td><td></td></tr>
<tr><td></td><td>Text book/s*</td><td colspan="3">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,
3..</td><td></td></tr>
<tr><td></td><td>Other References</td><td colspan="3">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 Integrated Circuits, PHI,2nd Edn.2006
3.Jacob Milliman and Arvin Grabel, “Microelectronics” , 2nd Edition ,TMH, 2008
12.</td><td></td></tr>
</table>

COURSE ARTICULATION MATRIX

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO101.1	3	1	1	1	-	-	-	-	-	-		-
CO101.2	2	2	3	3	2	-	-	-	2	2	2	2
CO101.3	2	3	3	2	3	-	-	-	3	2	2	2
CO101.4	3	3	3	3	2	-	-	-	-	1	2	1

SHARDA UNIVERSITY
Beyond Boundaries

School: SET		**Batch : 2019-21**	
Program: M.Tech		**Current Academic Year: 2019-21**	
Branch: EEE		**Semester: I**	
1	Course Code	MPS114	
2	Course Title	Modelling & Analysis of Power System	
3	Credits	4	
4	Contact Hours (L-T-P)	3-1-0	
	Course Status	Compulsory	
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	On successful 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.	
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
	B	Load flow equations, solution techniques- Gauss-Seidel	CO2
	C	Newton Raphson method and fast decoupled method	CO2
	Unit 3	**Load Flow with HVDC link**	
	A	DC system model, incorporation of control equations	CO3
	B	inverter and unified operation	CO3

	C	sequential solution techniques			CO3
	Unit 4	**Short Circuit Studies For Unbalanced Network**			
	A	Z-bus building algorithm, derivation of fault admittance matrices			CO4
	B	sequence components, analysis of unbalance shunt and series			CO4
	C	open circuit faults			CO4
	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	
		30%	20%	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.			

COURSE ARTICULATION MATRIX:

COs	PO1	PO1	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO114.1	2	1	-	1	1	1	2	2	1	1	2	2
CO114.2	2	1	-	-	1	-	-	-	2	1	1	2
CO114.3	2	2	-	2	1	-	2	2	2	2	1	1
CO114.4	2	-	-	1	1	1	-	-	2	1	2	2
CO114.5	3	1	3	2	3	1	2	2	3	2	2	3

School: SET		**Batch : 2019-21**
Program: M. Tech.		**Current Academic Year: 2019-21**
Branch: EEE		**Semester:** I
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	Compulsory
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	CO1: design and R&D requirements for the EHV AC Transmission including substation design. CO2: design and R&D requirements for the HVDC Transmission including converter station design. CO3: calculate line parameters of EHV transmission line. CO4: describe and classify different over-voltage protection situations and their possible protections. CO5: design shunt and series compensation in power 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, CO2
	B	calculation of impedance and capacitance matrices of 3-phase transmission line	CO3
	C	Electrostatic and Electromagnetic field, calculation of corona current/loss, radio interference, audible noise interference	CO1, CO2
	Unit 2	**Computation and Protection against Over-Voltage**	
	A	Causes of over voltages	CO1, CO2, CO4
	B	Methods of protection against switching surges	CO1, CO2, CO4
	C	Means of protection against lightning surges	CO1, CO2, CO4
	Unit 3	**Series and Shunt Compensation**	
	A	Effect of series capacitors, location of series capacitors	CO1, CO5

	B	Sub-synchronous resonance in series-capacitor compensated transmission lines			CO1, CO5
	C	Shunt compensation- conventional devices, static VAR compensation: TCR-FC, TCR, TSC-TCR devices			CO1, CO5
	Unit 4	**Design of Substations**			
	A	Types of substations, layout of substation			CO1
	B	bus bar arrangements, grounding system- types of grounding, design parameters			CO1
	C	designing a grounding grid, measurement of soil resistivity			CO1
	Unit 5	**HVDC Systems**			
	A	Types of HVDC systems			CO2
	B	Terminal equipment and their operations			CO2
	C	Dc link control and protection			CO2
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	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			

COURSE ARTICULATION MATRIX:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO122.1	2	3	3	1	2	-	-	-	2	2	2	1
CO122.2	2	3	3	1	2	-	-	-	2	2	2	1
CO122.3	3	1	-	-	-	-	-	-	1	-	-	3
CO122.4	2	2	3	2	3	-	-	-	2	3	3	1
CO122.5	2	2	3	2	3	-	-	-	2	3	3	1

School: SET		Batch : 2019-21	
Program: M.Tech		**Current Academic Year:** 2019-21	
Branch:EEE		**Semester:** I	
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	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 of optimization problems and solve various constrained and unconstrained problems CO5: Know various Evolutionary Techniques and Solve integer Programming problems.	
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, Regula falsi method, Newton	CO1

		Raphson method, secant method.			
	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 sufficient optimality conditions, Graphical method for optimal solution.			CO3
	C	Simplex method and Dual Simplex method			CO3
	Unit 4	**Optimization Techniques**			
	A	Lagrange multiplier, Kuhn-tucker conditions			CO4
	B	Newtons method, Interior Penalty function method,			CO4
	C	Rosen Gradient projection method			CO4
	Unit 5	**Evolutionary Techniques and Integer Programming**			
	A	Genetic Algorithm, Particle swarm and ant colony optimization methods			CO5
	B	Branch and Bound method			CO5
	C	cutting plane method			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1 Balagurusamy, E., "Numerical methods", Tata McGraw Hill 2 Rao S.S, "Enginering Optimization: Theory and Practice", wiley			
	Other References	3 Ravindran.A, "Engineering Optimization Methods and Applications", Wiley 4 Rao S.S, "Applied Numerical Methods for Engineers and Scientists", Pearson education 5 Burden R.L.anf Faires J.D, "Numerical Anlaysis", Brooks/coole			

		6 Song Y.H, "Modern Optimization Techniques in power systems", Kluver Academic 7 Deep K. And Chandra Mohan, Optimization Techniques", New Age International		

		8 Deb K, "Optimization for Engineering Design, PHI	

Course Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO104.1	3	1	2	-	-	-	-	-	2	-	-	-
CO104.2	2	3	-	1	-	-	-	-	2	-	-	-
CO104.3	2	3	2	-	-	-	-	1	2	-	3	-
CO104.4	2	3	1	2	-	1	-	-	3	2	2	2
CO104.5	2	3	2	2	-	1	-	1	2	2	2	2

School: SET		**Batch : 2019-21**
Program: M.Tech		**Current Academic Year: 2019-21**
Branch: EEE		**Semester:** II
1	Course Code	MPS 116
2	Course Title	Power System Reliability Assessment
3	Credits	3
4	Contact Hours (L-T-P)	3-1-0
	Course Status	
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
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
	B	Network modeling and evaluation of series, parallel, series – parallel and complex systems, cut-set method, tie-set method,	CO2

		discrete Markov chains, continuous Markov process.			
	C	Concept of frequency and duration technique, application to multi-state problems, approximate system reliability evaluation methods.			CO2
	Unit 3	**Generation System Reliability**			
	A	Generation system models, capacity outage table, recursive algorithm.			CO3
	B	Loss of load indices, inclusion of scheduled outages, load forecast uncertainty, loss of energy indices.			CO3
	C	Expected energy generation, energy limited systems, reliability evaluation, frequency and duration method.			CO3
	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
	B	Equivalent assistance unit method for reliability evaluation of inter-connected system.			CO4
	C	Elementary concepts of reliability evaluation of multi-connected systems, composite system reliability.			CO4
	Unit 5	**Distribution System Reliability**			
	A	Basic technique and application to radial systems, customer–oriented indices, load and energy indices.			CO5
	B	Effect of lateral distributor protection, effect of disconnects effect of protection failures, effect of load transfer.			CO5
	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
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	R. Billinton and R.N.Allan, "Reliability Evaluation of Power Systems", Pitman Advanced Publishing Program			
	Other References	1. R.Billinton and R.N.Allan, "Reliability Evaluation of Engineering Systems Concepts and Techniques", Pitman Advanced Publishing Program. 2. J.Endrenyi, "Reliability Modeling in Electric Power Systems", John Wiley & Sons.			

COURSE ARTICULATION MATRIX:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO116.1	2	-	-	1	1	-	-	-	1	1	2	2
CO116.2	2	-	-	-	1	1	-	-	2	1	1	2
CO116.3	2	2	-	2	1	-	-	-	2	2	1	1
CO116.4	2	-	-	1	1	-	-	-	2	2	2	2
CO116.5	3	1	3	2	3	1	-	-	3	2	3	2

SHARDA UNIVERSITY
Beyond Boundaries

School: SET		**Batch : 2019-21**	
Program: M. Tech.		**Current Academic Year: 2019-21**	
Branch: EEE		**Semester:** II	
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	Compulsory	
5	Course Objective	Learn modern numerical techniques and analytical methods for dealing with and solving operation-related problems in electric power systems	
6	Course Outcomes	After the completion of course student will be able to CO1: explore the concept of automatic generation control. CO2: apply the modes of excitation systems and exercises voltage control. CO3: employ incremental cost curve and penalty factor for economic operation. CO4: plan unit commitment for optimal operation. CO5: evaluate power system security and methods 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 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	Outline syllabus		CO Mapping
	Unit 1	**Economic Dispatch of Thermal Units**	
	A	Economic dispatch problem with and without line losses	CO3, CO6
	B	Solution methods-lambda-iteration technique, gradient search and Newton's method	CO3, CO6
	C	Optimal power flow method	CO3, CO6
	Unit 2	**Unit Commitment**	
	A	Unit Commitment problem, startup and shutdown 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 scheduling problem	CO6
	B	Solution by gradient method	CO6
	C	Pumped storage hydro-plant scheduling pumped storage hydro-plant	CO6

		scheduling			
	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	Generator 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	
		30%	20%	50%	
	Text book*	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			

COURSE ARTICULATION MATRIX:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO117.1	2	-	-	-	-	-	-	-	1	-	-	3
CO117.2	2	2	2	2	2	-	-	-	2	1	-	1
CO117.3	3	3	3	3	-	-	-	-	3	3	1	1
CO117.4	3	3	3	3	-	-	-	-	3	3	1	1
CO117.5	2	2	3	3	-	-	-	-	3	3	3	1
CO117.6	3	1	1	1	-	-	-	-	2	1	-	2

School: SET		**Batch : 2019-21**
Program: M.Tech		**Current Academic Year: 2019-21**
Branch: EEE		**Semester:** I/II
1	Course Code	MPS121
2	Course Title	Smart Power Grid and Micro-Grid
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Departmental Elective
5	Course Objective	1. To understand the concepts of smart power grid and micro grid 2. To acquire in depth knowledge of smart distribution, distribution automation, 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 micro grid for a given application
6	Course Outcomes	CO1: To understand concept, motivation and benefits of Smart Power Grid 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 area monitoring system using PMU
7	Course Description	The course deals with the concept of smart power grid and includes inv depth study of its its various components, namely smart distribution, distribution automation and management, advanced metering infrastructure , smart micro grid, smart transmission and substation automation.

8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Smart Power Grid (4 hours)**	
	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
	C	Stake-holders in smart-grid development, Smart grid solutions.	CO1
	Unit 2	**Smart Distribution**	
	A	Demand-side management: Energy efficiency, time of use and spinning reserve	CO2
	B	Demand response: Market driven DR and operation-driven DR, incentive-based DR and TOU-based rates DR	CO2

	C	Distributed generation, Energy storage, Use of plugged CO_2 electric and hybrid electric vehicles			
	Unit 3	**Distribution Automation and Management**			
	A	Overview of distribution system, Components of DA: customer automation, feeder automation 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
	Unit 4	**Smart Microgrid**			
	A	Definition, components and benefits of microgrid			CO4
	B	Types of micro grid: AC, DC and hybrid, Modes of operation: grid-connected and island modes			CO4
	C	Meaning of smart micro grid, Micro grid operation and control			CO4
	Unit 5	**Smart Transmission and Substation Automation**			
	A	Meaning and challenges of smart transmission			CO5
	B	Phasor measurement unit: concept, layout, components and applications, Wide area monitoring system: concept and impact on EMS and DMS			CO5
	C	Need of substation automation (SA), Technical issues of SA, SA architecture, SA function.			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Mini S. Thomas and John D. McDonald, Power System SCADA and Smart Grids, CRC Press, 2015.			
	Other References	1. Janak Eknayake at el., Smart Grid: Technology and Applications, John Wiley and Sons, 2012 2. H. K. Verma , e-Monograph on " Smart – Grid", www.profhkverma.info			

Course Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO121.1	3	2	1	-	-	3	-	-	3	-	-	-
CO121.2	3	2	1	2	1	2	-	-	2	3	2	1
CO121.3	2	1	3	1	1	1	-	-	2	2	2	2
CO121.4	2	1	3	2	1	2	-	-	1	3	2	2
CO121.5	3	2	3	1	2	1	-	-	3	2	3	3

School: SET		**Batch : 2019-21**
Program: M.Tech		**Current Academic Year: 2019-21**
Branch: EEE		**Semester:** II
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	Compulsory
5	Course Objective	1. to understand the concept of digital protection and computer relaying for power 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 power system apparatus
6	Course Outcomes	CO1: to compare, analyse 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 driving force for advances in relaying systems is the need to improve reliability. In turn, this implies increase in dependability as well as security. This need to improve 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 a digital relay	CO1
	C	Multifunctional 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 representation of system;	CO2 & CO6
	B	Z transform, sine and cosine Fourier series, Fourier Transform and DFT	CO2 & CO6
	C	Walsh functions, digital filters, windows and windowing.	CO2 & CO6
	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 & CO6
	C	Numerical differential protection of generator	CO3 & CO6
	Unit 4	**Digital Relaying for Transformer**	
	A	Types of faults encountered in transformer, basic considerations for transformer differential protection,	CO4
	B	stabilizing of differential protection during magnetizing inrush current	CO4
	C	Numerical protection of transformer	CO4
	Unit 5	Artificial Intelligence Based Numerical Protection	CO5
	A	Types of Neural Network Models, Artificial Neural Network, Design Procedure and Consideration	CO5
	B	Application of ANN to transmission line protection	CO5
	C	ANN based power transformer protection	
	Mode of examination	Theory	
	Weightage Distribution	CA: 30% · MTE: 20% · ETE: 50%	
	Text book/s*	1. Arun G Phadke and James S. Thorp, "Computer Relaying for Power Systems", John Wiley and Sons Inc, New York. 2. Badri ram, D.N.Vishwakarma, 'Power System Protection & Switchgear', Tata McGraw –hill publishing company ltd, New Delhi.	
	Other References	1. Bhavesh Bhalja, R.P. Maheswari and Nilesh G. Chothani, "Protection and Switchgear", Oxford.	

Course Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO123.1	1	2	3	-	-	-	-	-	1	2	2	1
CO123.2	2	1	2	2	1	-	-	-	-	2	2	1
CO123.3	-	-	3	2	-	-	-	-	2	1		3
CO123.4	2	1	1	2	-	-	-	-	1	2	1	2
CO123.5	1	2	2	3	-	-	-	-	-	2	1	-
CO123.6	2	2	2	`1	-	-	-	-	-	1		3

School: SET		**Batch : 2019-21**
Program: M. Tech.		**Current Academic Year: 2019-21**
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	To impart 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 operations of different FACTS devices. CO2: Select the controllers for different Contingencies. CO3: Analyze the different FACTS devices in different stability conditions. CO4. 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	CO3
	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, applications of SVC and STATCOM	CO1,CO3, CO4
	C	Principal of operation and configuration of TCSC and SSSC	CO1,CO3, CO4
	Unit 4	**Unified power flow controller**	
	A	Basic operating principles	CO1,CO3, CO4

	B	Characteristics of UPFC			CO1,CO3, CO4
	C	Dynamic performance, steady state analysis and control			CO1,CO3, CO4
	Unit 5	**Stability analysis**			
	A	Oscillation stability analysis			CO3
	B	Transient stability control			CO3
	C	Protection issues with FACTS device			CO3
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	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			

COURSE ARTICULATION MATRIX:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO123.1	2	2	1	1	1	-	-	-	2	1	1	2
CO123.2	1	3	3	1	2	-	-	-	3	2	1	2
CO123.3	2	1	1	2	1	-	-	-	2	1	1	2
CO123.4	1	3	3	1	3	-	-	-	2	3	3	1

School: SET		**Batch : 2019-21**
Program: M.Tech		**Current Academic Year: 2019-21**
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	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	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 d.c motor speed control using converters and choppers CO5: Identify the use of drives in industrial applications
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 (5 hours)**	
	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 (5 hours)**			
	A	Review of dc chopper and duty ratio control, chopper fed dc motor for speed control			CO2
	B	steady state operation of a chopper fed drive, armature current waveform and ripple,			CO2
	C	calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting			CO2
	Unit 3	**Multi-quadrant DC drive (6 hours)**			
	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
	Unit 4	**Closed-loop control of DC Drive (6 hours)**			
	A	Control structure of DC drive, inner current loop and outer speed loop,			CO4
	B	dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay			CO4
	C	plant transfer function, for controller design, current controller specification and design, speed controller specification and design.			CO4
	Unit 5	**Induction motor characteristics (6 hours)**			
	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
	C	Typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation.			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	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.	

Course Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO125.1	2	1	-	-	-	-	-	-	1	2	1	1
CO125.2	1	2	2	-	-	-	-	2	2	2	-	1
CO125.3	2	2	2	-	2	-	-	-	-	-	-	1
CO125.4	2	2	-	-	-	-	-	-	-	-	-	1
CO125.5	1	1	-	-	-	-	-	-	-	-	1	-

School: SET		**Batch : 2019-21**
Program: M.Tech		**Current Academic Year: 2019-21**
Branch: EEE		**Semester:** I/II
1	Course Code	EEE007
2	Course Title	Power Quality
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Departmental Elective
5	Course Objective	1. Understand the various power quality phenomenon, their origin and monitoring and mitigation methods. 2. Analyze the effects of various power quality phenomenon in various Equipments 3. Analyze the different measuring and monitoring equipments for power quality issues 4. Analyse the different filters, conditioners or protecting equipments used for mitigation of power quality problems
6	Course Outcomes	CO1: Understand the various terminologies used in power quality studies in order to define and characterize its features CO2: Analyse the different methods for mitigation of sags and interruptions. CO3:Analyse the various sources of overvoltage in power distribution system CO4: Analyse the effects of harmonics in power system equipments. CO5: Analyze and compare different measurement and monitoring equipment for power quality issues
7	Course Description	The course addresses various issues related to power quality in power distribution systems. Power systems are ideally designed to operate three-phase balanced load at fundamental frequency. When there is deviation from these ideal conditions, the efficiency of power system comes down. This is due to increased losses, heating of electric machines, transformers and appliances. These aspects will be explained along with practical examples. In this course, the consequences of power quality problems will be discussed and an effort will be made to understand their mitigation using filters, power conditioners and protection equipments.
8	Outline syllabus	CO Mapping

	Unit 1	**Introduction to Power Quality**			
	A	Terms and definitions, overloading, under voltage, sustained interruption,			CO1
	B	sags and swells, waveform distortion, total harmonic distortion (THD)			CO1
	C	Computer business equipment manufacturers associations (CBEMA) curve.			CO1
	Unit 2	**Voltage Sags and Interruptions**			
	A	Sources of sags and interruptions, estimating voltage sag performance			CO2
	B	motor starting sags, estimating the sag severity, mitigation of voltage sags			CO2
	C	active series compensators, static transfer switches and fast transfer switches.			CO2
	Unit 3	**Overvoltage**			
	A	Sources of overvoltages, capacitor switching, lightning, ferro resonance, mitigation of voltage swells, surge arresters,			CO3
	B	low pass filters, power conditioners, lightning protection, shielding, line arresters			CO3
	C	computer analysis tools for transients			CO3
	Unit 4	**Harmonics**			
	A	Harmonic distortion, voltage and current distortion, harmonic indices, harmonic sources from commercial and industrial loads,			CO4
	B	locating harmonic sources; power system response characteristics, resonance,			CO4
	C	Harmonic distortion evaluation, devices for controlling harmonic distortion, passive filters, active filters, IEEE and IEC standards.			CO4
	Unit 5	**Power Quality Monitoring**			
	A	Monitoring considerations, Power line disturbance analyzer, power quality measurement equipment,			CO5
	B	harmonic / spectrum analyzer, flicker meters, disturbance analyzer			CO5
	C	applications of expert system for power quality monitoring.			CO5
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Roger.C.D., Mark.F.M., Surya Santoso, H.Wayne			

		Beaty, 'Electrical Power Systems Quality' McGraw Hill, 2003 2. Arrillaga J.,Simith B.C. ,Watson N.R. and Wood A.R. "Power System Harmonics Analysis" John Willey &Sons 1997	
	Other References	1. Wakipen G.J., "Power System Harmonics : Fundamentals ,Analysis and Filter design" Springer,2001	

Course Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO007.1	2	1	1	2	1	-	-	-	1	-	-	2
CO007.2	1	2	2	1	2	-	-	-	2	1	-	1
CO007.3	1	2	1	-	-	-	-	-	-	-	-	-
CO007.4	2	1	2	1	-	-	-	-	-	-	-	-
CO007.5	2	1	1	1	-	-	-	-	-	-	-	-

School: SET		**Batch** : **2019-21**
Program: M.Tech		**Current Academic Year**: 2019-21
Branch: EEE		**Semester:** I
1	Course Code	MPS152
2	Course Title	Power System Modelling & Simulation Lab
3	Credits	1
4	Contact Hours (L-T-P)	0-0-2
	Course Status	Compulsory
5	Course Objective	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	On successful completion of this course students will be able to CO1: Analyze the power system data for load-flow and fault studies. CO2: Apply computational methods for large scale power system studies. CO3 :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		
	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	Three-Phase 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	Load Flow with HVDC link	
	A	Modelling of HVDC link	CO2
	B	DC load flow study	CO2
	Unit 4	Short Circuit Studies For Unbalanced Network	

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	A	Simulation of symmetrical fault			CO2
	B	Simulation of Unsymmetrical fault			CO2
	C	Simulation of symmetrical fault in presence of compensator			CO2
	Unit 5	State Estimation			
	A	State estimation of a power system			CO3
	B	State estimation of a power system using Weighted Least Square method			CO3
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	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.			

COURSE ARTICULATION MATRIX:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO152.1	2	1	-	1	1	1	2	2	1	1	2	2
CO152.2	2	1	-	-	1	-	-	-	2	1	1	2
CO152.3	2	2	-	2	1	-	2	2	2	2	1	1

School: SET		**Batch: 2019-21**
Program: M. Tech.		**Current Academic Year: 2019-21**
Branch: EEE		**Semester:** II
1	Course Code	MPS153
2	Course Title	Power System Control and Protection Lab
3	Credits	2
4	Contact Hours (L-T-P)	0-0-4
	Course Status	Compulsory
5	Course Objective	Learn 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 automatic generation control. CO2: apply the modes of excitation systems and exercises voltage control. CO3: employ incremental cost curve and penalty factor for economic operation. CO4: plan unit commitment for optimal operation. CO5: evaluate power system security and methods of improvement. CO6: analyse power system faults for balanced and unbalanced conditions. CO7: compare the protection techniques used for protection of different power system components
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 economic load dispatch and Unit Commitment**	
	A	To perform economic load dispatch without considering losses using MATLAB	CO3
	B	To perform economic load dispatch with considering losses using MATLAB	CO3
	C	To solve unit commitment method using priority list scheme in MATLAB	CO4
	Unit 2	**Practical related to load frequency control and voltage**	

		control	
	A	To design load frequency control model in MATLAB	CO1
	B	To connect shunt capacitor in most optimal location and to study improvement in voltage profile using MATLAB/PSCAD.	CO2
	C	To connect series capacitor in most optimal location and to study improvement in power transfer capability using MATLAB/PSCAD	CO2
	Unit 3	**Practical related to power system security and excitation control**	
	A	To design DC/AC excitation control model in PSCAD.	CO2
	B	To design static excitation control model in PSCAD.	CO2
	C	To evaluate security index of a system using contingency analysis in MATLAB	CO5
	Unit 4	**Practical related to fault analysis**	
	A	To simulate single line to ground in PSCAD and to measure voltage and current at different locations	CO6
	B	To simulate line to line in PSCAD and to measure voltage and current at different locations	CO6
	C	To simulate double line to ground in PSCAD and to measure voltage and current at different locations	CO6
	Unit 5	**Practical related to relay**	
	A	Principle of various Electromagnetic relays and their constructions.	CO7
	B	Over-current, directional, differential and distance relays and their operating characteristics	CO7
	C	Modern relays: introduction to static and digital/numerical (microprocessor based) relays and Intelligent Electronic Device(IED) relays	CO7
	Mode of examination	Practical	
	Weightage Distribution	CA: 60% / MTE: 0% / ETE: 40%	
	Text book/s*	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	

COURSE ARTICULATION MATRIX:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO153.1	2	-	-	-	-	-	-	-	1	-	-	3
CO153.2	2	2	2	2	2	-	-	-	2	1	-	1
CO153.3	3	3	3	3	-	-	-	-	3	3	1	1
CO153.4	3	3	3	3	-	-	-	-	3	3	1	1
CO153.5	2	2	3	3	-	-	-	-	3	3	3	1
CO153.6	3	2	-	-	-	-	-	-	2	2	-	2
CO153.7	3	2	-	-	-	-	-	-	2	2	-	2

School: SET		**Batch : 2019-2021**	
Program: M.Tech		**Current Academic Year: 2019-2021**	
Branch: EEE		**Semester:**	
1	Course Code	MPS129	
2	Course Title	Distributed Generation Technology	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Elective	
5	Course Objective	To introduce the concept of distributed generation, microgrids, electric vehicles and energy storage. To familiarize the students with renewable generation system modelling, and their grid integration issues. To impart an understanding of economics, policies and technical regulations for DG integration	
6	Course Outcomes	CO1 : Analyse the concept and importance of distributed generation. CO2: Understand different renewable energy sources, micro-grid and storage Devices. CO3: Evaluate the technical impact of DG in power system CO4: Analyze the operation and control strategies for grid connected and off-grid System. CO5: Evaluate the effect of DG placement in the existing system.	
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**