B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

Regulation 2019

OPEN ELECTIVES (OE)

(Offered by Department of Electronics and Communication Engineering)

Sl. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	U19EC601	Discrete Time Signal Processing	OE	3	3	0	0	3
2	U19EC602	Principles of Analog and Digital Communication	OE	3	3	0	0	3
3	U19EC603	Digital Systems and VLSI Design	OE	3	3	0	0	3
4	U19EC604	Introduction to IoT	OE	4	2	0	2	3
5	U19EC605	Basics of Biomedical Instrumentation	OE	3	3	0	0	3
6	U19EC606	Introduction to Image processing	OE	3	3	0	0	3
7	U19EC607	Microcontroller and Embedded Systems	OE	4	2	0	2	3
8	U19EC608	Introduction to wireless sensor Networks	OE	3	3	0	0	3
9	U19EC609	Introduction to Robotics and Automation	OE	3	3	0	0	3

***** Open Elective –L T P C for Open Electives can either be 3 0 0 3 or 2 0 2 3

U19EC601	DIGITAL-TIME SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

Upon completion of this course, students will be able to:

Outcomes			
	CO1	**(Understand)** Understand discrete Fourier transform, properties of DFT and its application to linear filtering	K2
	CO2	**(Apply)**Understand the characteristics of digital filters and apply the design in digital IIR filters	K3
	CO3	**(Apply)** Understand the characteristics of digital filters and apply the design in digital FIR filters	K3
	CO4	**(Understand)**Understand the concepts of precision in digital signal processing and the associated errors	K2
	CO5	**(Understand)**Understand the architecture of DSP processor and its usage for real time applications	K2

MODULE I **DISCRETE FOURIER TRANSFORM** **9**

Review of signals and systems, Discrete Fourier transform (DFT) -properties of DFT - periodicity, symmetry, circular convolution, Filtering long data sequences - overlap save and overlap add method.Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT), Decimation-in-frequency (DIF) Fast Fourier transform (FFT).

MODULE II **INFINITE IMPULSE RESPONSE FILTERS** **9**

Characteristics of commonly used analog filters - Butterworth filters, Chebyshev filters. Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) - Impulse invariance method, Bilinear transformation. Structure of IIR filter - direct form I, direct form II.

MODULE III **FINITE IMPULSE RESPONSE FILTERS** **9**

Design of FIR filters - symmetric and Anti-symmetric FIR filters - design of linear phase FIR filters using Fourier series method - FIR filter design using windows (Rectangular Hamming and Hanning window), FIR filter structures - linear phase structure.

MODULE IV **FINITE WORD LENGTH EFFECTS** **9**

Fixed point and floating point number representation - ADC - quantization - truncation and rounding - quantization noise - input / output quantization - coefficient quantization error - product quantization error - overflow error.

MODULE V **INTRODUCTION TO DIGITAL SIGNAL PROCESSORS** **9**

DSP functionalities – DSP architecture – Fixed and Floating point architecture principles – Applications of DSP in RADAR, Voice Processing and Image Processing.

TOTAL: 45HOURS

TEXTBOOKS:

1. John G. Proakis& Dimitris G. Manolakis, —Digital Signal Processing – Principles, Algorithms & Applications‖, Fourth Edition, Pearson Education / Prentice Hall, 2007.

REFERENCES:

1. Emmanuel C. Ifeachor& Barrie. W. Jervis, —Digital Signal Processing‖, Second Edition, Pearson Education / Prentice Hall, 2002.
2. A. V. Oppenheim, R.W. Schafer and J.R. Buck, —Discrete-Time Signal Processing‖, 8th Indian Reprint, Pearson, 2004.
3. Sanjit K. Mitra, —Digital Signal Processing – A Computer Based Approach‖, Tata McGraw Hill, 2007.
4. Andreas Antoniou, —Digital Signal Processing‖, Tata McGraw Hill, 2006.

U19EC602	PRINCIPLES OF ANALOG AND DIGITAL COMMUNICATIONS	L	T	P	C
		3	0	0	3

Outcomes			
	Upon completion of this course, students will be able to		
	CO1	**(Apply)** Apply the basic concepts of modulation techniques in generation of amplitude modulation.	K3
	CO2	**(Apply)** Apply the basic concepts of modulation techniques in generation and demodulation of angle modulation.	K3
	CO3	**(Analyze)** Analyze the performance of various digital transmission techniques for noisy channel conditions.	K4
	CO4	**(Apply)** Apply the basic concepts of modulation techniques in generation of various digital modulation schemes.	K3
	CO5	**(Analyze)** Analyze the concepts of various information coding techniques and its applications.	K4

MODULE I	FUNDAMENTALS OF AMPLITUDE MODULATION	9

Introduction – AM: Time Domain description – Frequency Domain description – Generation of AM wave: Square law modulator– Switching modulator – Detection of AM waves: Envelope detector – DSB-SC modulation: Generation of DSB-SC waves – Balanced modulator – Ring modulator – SSB-SC modulation: Phase discrimination method– Super Heterodyne Receiver.

MODULE II	ANGLE MODULATION SYSTEMS	9

Introduction – Narrow band FM – Wideband FM – Transmission bandwidth of FM waves – Generation of FM waves: Indirect FM and Direct FM – Carson's Rule – FM demodulation – PLL demodulator – Balanced slope detector – Foster Seeley Discriminator – Ratio detector – Pre-emphasis and De-emphasis in FM.

MODULE III	DIGITAL TRANSMISSION	9

Introduction – Sampling theorem – Pulse modulation –PCM – ADPCM - Differential Pulse Code Modulation (DPCM)– Quantization – Companding – Delta Modulation (DM) – Adaptive Delta Modulation (ADM) – Inter symbol Interference (ISI) – Eye Pattern.

MODULE IV	DIGITAL MODULATION TECHNIQUES	9

Detection using matched filters for signals via AWGN channels - Modulations - Generation and detection of BPSK, QPSK, DPSK and QAM - Signal space constellation - Computation of the probability of bit error for BPSK – QPSK - Matched Filter.

MODULE V	BASICS OF INFORMATION THEORY CODING	9

Measurement of Information - Entropy and information rate – Discrete memory less source- Communication channels - Shannon's Channel Capacity theorem - Self information measure - Entropy function - Conditional Entropies - Mutual information - Redundancy - Efficiency and channel capacity- Source Encoding: Shannon Fano coding, Huffman coding.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Simon Haykin, "Communication Systems", Wiley Publication, New Delhi, 2011.
2. Sanjay Sharma, — Communication Systems (Analog and Digital), S.K. Kataria& Sons; Reprint 2013.

REFERENCES:

1. Bernard Sklar, "Digital Communications- Fundamentals and applications", Pearson Education, New Delhi, 2009.
2. J.G Proakis, —Digital Communication‖, 5/e, Tata Mc Graw Hill Company, 2008.
3. K Sam Shanmugam, Digital and Analog Communication Systems, Wiley, 1994.

U19EC603	DIGITAL SYSTEMS AND VLSI DESIGN	L	T	P	C
		3	0	0	3

Outcomes	Upon completion of this course, students will be able to:		
	CO1	**(Apply)** Implementation of combinational circuits using logic gates	K3
	CO2	**(Analyze)**Analyze and design of synchronous sequential digital circuits	K4
	CO3	**(Apply)** Implementation of the PLDs proposed for combinational circuit design	K3
	CO4	**(Understand)** Discuss the fundamentals of CMOS circuits and ASIC Design.	K2
	CO5	**(Apply)** Design a digital logics using Verilog HDL	K3

MODULE I	**COIMBINATIONAL CIRCUITS**	**9**
Karnaugh map Minimization – Don't care conditions - Design procedure – Half adder – Full Adder – Half subtractor – Full subtractor - Parallel binary adder, parallel binary Subtractor - BCD adder - Multiplexer/ Demultiplexer – decoder - encoder - code converters.		
MODULE II	**SEQUENTIAL CIRCUITS**	**9**
Flip flops – SR, D, JK, T – Flip flop Conversion - Analysis and design of clocked sequential circuits – Moore/Mealy models, state minimization, state assignment, logic implementation –2 bit Synchronous counter – 2 bit Asynchronous Counter - Shift registers- Hazards.		
MODULE III	**MEMORY DEVICES**	**9**
RAM - ROM - Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA) - Implementation of combinational logic circuits using PLA, PAL, and PROM.		
MODULE IV	**INTRODUCTION TO MOS TRANSISTOR AND ASIC DESIGN**	**9**
MOS Transistor - CMOS logic – Inverter – CMOS Fabrication - ASIC Design Flow - Types of ASICs - FPGA building block architectures – FPGA interconnect routing procedures.		
MODULE V	**BASICS OF VERILOG HDL**	**9**
Importance of HDL - Design Methodologies - Basic Concepts - Data Types - Dataflow Modeling - Verilog Operators - Gate Level Modeling - Behavioral Modeling: if, else, case statement		
		TOTAL: 45 HOURS

TEXTBOOKS:

1	M. Morris Mano and Michael D. Ciletti, —Digital Design, 5th Edition, Pearson, 2014.
2	Neil H.E. Weste, David Money Harris —CMOS VLSI Design: A Circuits and Systems Perspective, 4th Edition, Pearson , 2017

REFERENCES:

1	Leach D, Malvino A P &Saha, "Digital Principles and Applications" 8th Edition, Tata McGraw-Hill Publishing Company, 2014.
2	Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", 3rd Edition, Tata McGraw Hill, 2014.
3	Samir Palnitkar, "Verilog HDL", Pearson Education, 2nd Edition, 2004.
4	Thomas L.Floyd, "Digital Fundamentals", Prentice Hall, 11th Edition, 2015.

U19EC604	INTRODUCTION TO IOT	L	T	P	C
		3	0	0	3

Outcomes	Upon completion of this course, students will be able to:		
	CO1	**(Understand)** Understand the basic concepts of Internet of Things and its architecture.	K2
	CO2	**(Apply)** Apply the basic concepts of protocols and programming for data transfer in IoT.	K3
	CO3	**(Analyze)** Analyze the various cloud platforms and the programming languages of IoT.	K4
	CO4	**(Analyze)** Choose andwork on various target boards and clouds to implement IoT.	K4
	CO5	**(Analyze)**Analyze the various IoT case studies to understand IoT applications.	K5

MODULE I	**INTERNET OF THINGS AN OVERVIEW**	**9**

Definition and Characteristics of IoT - Physical Design of IoT - Logical design of IoT - IoT enabled Technologies: Wireless Sensor Networks, Cloud Computing, Big data analytics, Communication protocols and Embedded Systems - IoT Levels & Deployment Templates - Domain Specific IoTs : Home, City, Environment, Energy, Retail, Logistics, Agriculture, Industry, health and Lifestyle.

MODULE II	**IOT ARCHITECTURE**	**9**

Communication Protocols - IoT and M2M : Software Defined Networking, Network function virtualization- IoT System Management with NETCONF-YANG, SNMP, NETOPEER.

MODULE III	**PYTHON PROGRAMMING**	**9**

Language features of Python - Data types - Data structures - Control of flow - Functions – Modules – Packages - File handling - Data/time operation - Classes - Exception handling - Python packages: JSON, XML, HTTPLib, URLLib, SMTPLib.

MODULE IV	**IOT PHYSICAL DEVICES AND SERVERS**	**9**

Building blocks of an IoT device - Programming Inputs and outputs, Serial, SPI and I2C - Sensors and sensor Node and interfacing using any Embedded target boards : Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino) Cloud Support : Cloud Storage models and communication APIs Webserver - Web server for IoT - Cloud for IoT - Amazon Web services for IoT

MODULE V	**CASE STUDY AND IOT APPLICATION DEVELOPMENT**	**9**

Home Automation – Smart cities - Environment - Agriculture - Productivity Applications – Healthcare - Automotive/Vehicular IoT- Smart grid

TOTAL: 45 HOURS

TEXTBOOKS:

1	ArshdeepBahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2014.
2	VlasiosTsiatsis, Stamatis Karnouskos, Jan Holler, David Boyle, Catherine Mulligan, "Internet of Things: Technologies and Applications for a New Age of Intelligence", Academic Press, 2019.

REFERENCES:

1	Cuno Pfister, " Getting Started with the Internet of Things", O'Reilly Media Press, 2011
2	Jamil Y. Khan, Mehmet R. Yuce, "Internet of Things (IoT): Systems and Applications", Jenny Stanford Publishing, 2019

U19EC605	BASICS OF BIOMEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

Outcomes			
	Upon completion of this course, students will be able to		
	CO1	**(Understand)**Understand basic human body functions and life processes.	K2
	CO2	**(Apply)**Apply the concepts of sensing for various physiological measurements.	K3
	CO3	**(Apply)** Apply the knowledge of amplifiers to record various physiological signals.	K3
	CO4	**(Understand)**Understand various techniques of non electrical physiological measurements.	K2
	CO5	**(Understand)**Understand the working of various instruments used in biochemical measurements.	K2

MODULE I	HUMAN ANATOMY AND BIO POTENTIAL GENERATION	9

Introduction to human physiology - The Cardiovascular System, The Nervous system- Neuronal Communication, Neuronal receptors Biometrics, Sources of bio potentials, Man Instrument System.

MODULE II	BIOSIGNAL ELECTRODES AND MEASUREMENTS	10

Bio potential electrodes - Surface, Needle and Micro Electrodes and their equivalent circuits, Recording problems, ECG – Einthoven's Triangle, Standard 12 lead System. EEG – 10-20 Electrode System, EMG– Unipolar and Bipolar Mode.

MODULE III	BIOELECTRIC AMPLIFIERS	9

Bioelectric amplifiers, operational amplifiers, basic amplifier configurations- Inverting and Non-Inverting, Differential amplifiers and Isolation amplifiers.

MODULE IV	PHYSIOLOGICAL PRESSURE AND OTHER CARDIOVASCULAR MEASUREMENTS AND DEVICES	9

Blood pressure measurement, Cardiac output measurement, Blood flow measurements, Defibrillators and Pacemakers.

MODULE V	INSTRUMENTATION FOR THE CLINICAL LABORATORY	8

The blood - Tests on blood cell - Blood cell counter, Chemical tests-colorimeter, Filter Photometer, Flame photometer, Spectrophotometer, Automation of Chemical test.

TOTAL: 45 HOURS

TEXTBOOKS:

1. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2007. (Units I, II, V)
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004. (Units III & IV)

REFERENCES:

1. Myer Kutz, "Standard Handbook of Biomedical Engineering and Design", McGraw Hill Publisher, 2003.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2003.(Units II & IV)
3. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2004.

U19EC606	INTRODUCTION TO IMAGE PROCESSING	L	T	P	C
		3	0	0	3

Outcomes			
	Upon completion of this course , students will be able to:		
	CO1	**(Understand)** Understanding the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms.	K2
	CO2	**(Remember)** Operate on images using the techniques of smoothing, sharpening and enhancement	K1
	CO3	**(Understand)** Understand the restoration concepts and filtering techniques.	K2
	CO4	**(Remember)** Remembering the basics of segmentation, features extraction methods for color models.	K1
	CO5	**(Remember)** Remembering the basics of compression and recognition methods for color models.	K1

MODULE I	DIGITAL IMAGE FUNDAMENTALS	9

Steps in Digital Image Processing, Components, Elements of Visual Perception , Image Sensing and Acquisition , Image Sampling and Quantization , Relationships between pixels , Color image fundamentals , RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.

MODULE II	IMAGE ENHANCEMENT	9

Intensity transformation functions, Histogram processing, Histogram equalization, Spatial filtering: Fundamentals - Smoothing and sharpening using spatial filters, Filtering in the frequency domain: Smoothing and sharpening using frequency domain filters

MODULE III	IMAGE RESTORATION	9

Image Restoration , degradation model, Properties, Noise models , Mean Filters , Order Statistics , Adaptive filters , Band reject Filters , Band pass Filters , Notch Filters , Optimum Notch Filtering , Inverse Filtering , Wiener filtering.

MODULE IV	IMAGE SEGMENTATION	9

Point, Line and edge detection, Thresholding, Region based segmentation: Region growing - Region splitting and merging, Representation and description: Chain codes - Shape numbers.

MODULE V	IMAGE COMPRESSION AND RECOGNITION	9

Need for data compression, Huffman, Run Length Encoding, JPEG standard, MPEG. Boundary representation, Boundary description, Texture, Patterns and Pattern classes, Recognition based on matching.

TOTAL: 45 HOURS

TEXTBOOKS:

1	Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing‘, Pearson, Third Edition, 2010.
2	Jayaraman S, Esakkirajan S and Veerakumar T, —Digital Image Processing‖, Tata McGraw Hill, New Delhi, 2009.

REFERENCES:

1	Anil K. Jain, Fundamentals of Digital Image Processing, Pearson, 2002.
2	Kenneth R. Castleman, Digital Image Processing‘, Pearson, 2006
3	William K. Pratt, Digital Image Processing‘, John Wiley, New York, 2002
4	Milan Sonka et al Image processing, analysis and machine vision‘, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.

U19EC607	MICROCONTROLLER AND EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

Outcomes			
	Upon completion of this course, students will be able to:		
	CO1	**(Understand)** Understand the architectural features of microcontrollers.	K2
	CO2	**(Apply)** Apply the basic concepts of assembly language programming to perform any task.	K3
	CO3	**(Apply)** Apply the concepts of interfacing with various peripherals.	K3
	CO4	**(Analyze)**Analyze the performance of data transfer and sensor communication in micro-controllers.	K4
	CO5	**(Design)**Design an embedded system for a real time application.	K4

MODULE I	INTRODUCTION TO MICROCONTROLLER 8051	9

The 8051 Architecture- Oscillator and clock-program counter –data pointer-registers- stack pointer-special function registers- -memory organization-program memory-data memory -Input / Output Ports - Interrupts

MODULE II	8051 ASSEMBLY LANGUAGE PROGRAMMING	9

Structure of Assembly language -Addressing modes- Instruction set- Arithmetic operations and Programs- Logicaloperations and Programs -Jump and Call instructions -I /O Pot Programs -Single bit instructions– Timer and counter

MODULE III	EMBEDDED SYSTEMS AN OVERVIEW	9

Embedded Vs General computing system, Classification of Embedded systems, Major applications and purpose of ES - Core of an Embedded System – All processor/controller, Memory, Sensors, Actuators – Communication Interface – Characteristics of Embedded system – Qualitative attributes of Embedded system

MODULE IV	RTOS BASED EMBEDDED SYSTEM DESIGN	9

Operating System basics - Types of operating systems - Task, process and threads - Task scheduling – Task communication - How to choose an RTOS - Integration and testing of Embedded hardware and firmware - Embedded system Development Environment: IDE, Cross compilation

MODULE V	Case Study	9

Case study: Digital clock – Battery operated Smart Card Reader – Automated Meter Reading System – Digital Camera – Washing Machine

TOTAL: 45 HOURS

TEXT BOOKS:

1	Muhammad Ali Mazidi, Janice GillispieMazidi and Rolin D. McKinlayt, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson, Second Edition
2	Shibu K V, Introduction to Embedded Systems, Tata McGraw Hill Education Private

REFERENCE BOOKS:

1	The 8051 Microcontrollers Architecture, Programming & Applications Kenneth J. Ayala
2	Embedded Systems: Architecture, Programming And Design, By Raj Kamal Second Edition, Tata McGraw Hill Education Private

U19EC608	INTRODUCTION TO WIRELESS SENSOR NETWORKS	L	T	P	C
		3	0	0	3

Outcomes			
	Upon completion of this course, students will be able to		
	CO1	**(Understand)**Know the basics of Wireless Sensor Networks.	K2
	CO2	**(Understand)**Learn the architecture and placement strategies of Sensors.	K2
	CO3	**(Apply)**Apply this knowledge to identify the suitable routing algorithm based on the network and user requirement.	K3
	CO4	**(Understand)**Understand the topological infrastructure and mechanism of data storage in wireless sensor networks.	K2
	CO5	**(Apply)**Be familiar with the OS used in Wireless Sensor Networks and build basic modules.	K3

MODULE I	INTRODUCTION	9

Introduction: Introduction to Sensor Networks, Characteristic requirements for WSN, unique constraints and challenges, Advantage of Sensor Networks, Applications Platforms for WSN, Mobile Adhoc Networks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks

MODULE II	ARCHITECTURE OF SENSOR NETWORK	9

Sensor Node Hardware and Network Architecture: Single-Node Architecture – Hardware Components & design constraints, Energy Consumption of Sensor Nodes, Network Architecture – Sensor Network Scenarios, Transceiver Design Considerations, Optimization Goals and Figures of Merit.

MODULE III	WSN PROTOCOLS	9

MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts – S-MAC, The Mediation Device Protocol, Contention based protocols – PAMAS, Schedule based protocols – LEACH, IEEE 802.15.4 MAC protocol, Routing Protocols - Energy Efficient Routing.

MODULE IV	WSN INFRASTRUCTURE ESTABLISHMENT AND DATA STORAGE	9

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control. Data Storage and Manipulation: Data centric and content based routing, storage and retrieval in network, compression technologies for WSN.

MODULE V	SENSOR NETWORK PLATFORMS AND TOOLS	9

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms – TinyOS, nesC, CONTIKIOS, Node-level Simulators – NS2 and its extension to sensor networks.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Holger Kerl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Network", John Wiley and Sons, 2005 (ISBN: 978-0-470-09511-9)
2. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks,An Information Processing Approach",Elsevier publications,2004

REFERENCES:

1. Raghavendra, Cauligi S, Sivalingam, Krishna M., ZantiTaieb, "Wireless Sensor Network",Springer 1st Ed. 2004 (ISBN: 978-4020-7883-5).

   Kazem, Sohraby, Daniel Minoli, TaiebZanti, "Wireless Sensor Network: Technology, Protocols and Application", John Wiley and Sons 1st Ed., 2007 (ISBN: 978-0-471-74300-2).
2. N. P. Mahalik, "Sensor Networks and Configuration: Fundamentals, Standards, Platforms, and Applications" Springer Verlag.
3. Sitharama Iyengar S, Nandan Parmeshwaran, Balkrishnan N and Chuka D, "Fundaments of Sensor Network Programming, Applications and Technology", John Wiley & Sons, 2011.

U19EC609	INTRODUCTION TO ROBOTICS AND AUTOMATION	L	T	P	C
		3	0	0	3

Outcomes

Upon completion of this course, students will be able to:

CO1	**(Understand)** Explain the various types of robots and its attributes	K2
CO2	**(Understand)** categorize the input and output interfacing of robot for an application	K2
CO3	**(Understand)** Outline the kinematics and dynamics of robots.	K2
CO4	**(Apply)** Utilize the concepts of PLC to develop ladder logic for Industrial applications.	K3
CO5	**(Understand)** Explain the principles applied to Industrial automation.	K2

MODULE I BASICS OF ROBOTICS **9**

History of robots - Specifications of Robots - Classifications of robots - Present status and future trends - Flexible automation versus Robotic technology – Basic components of robotic system - Basic terminology: Accuracy, Repeatability, Resolution, Degree of freedom, Mechanisms and transmission, End effectors and Grippers - Concepts of ROS, Gazebo, Kinect, Open NI and PCL - Robot applications Material handling, Machine loading and unloading, Assembly, Inspection, Welding, Spray painting.

MODULE II DRIVE SYSTEMS AND SENSOR **9**

Drive system: Hydraulic, Pneumatic and Electric systems (Servo drive control and Stepper Motor Control) – Sensors in Robot : Touch sensors, Tactile sensor, Proximity and ultrasonic range sensors, Robotic vision sensor, Force sensor, Light sensors and Pressure sensors.

MODULE III KINEMATICS AND DYNAMICS OF ROBOTS **9**

2D and 3D Transformation, Scaling, Rotation, Translation, Homogeneous coordinates, multiple transformation - Simple problems - Matrix representation - Forward and Reverse Kinematics of Three Degree of Freedom - Homogeneous Transformations - Inverse kinematics of Robot - Robot Arm dynamics - D-H representation of robots - Basics of Trajectory Planning.

MODULE IV INTRODUCTION TO PLC **9**

Need for PLC - PLC evolution - Architecture of PLC - Types of PLC – PLC modules, PLC Configuration -Scan cycle - Capabilities of PLC - Selection criteria for PLC – PLC Communication - I/O interfacing –Sensors – Programming: Types of programming - Ladder logic: Arithmetic, Counters, Timers and Registers. HMI - Need for HMI in Industrial Automation.

MODULE V AUTOMATION **9**

Introduction to Industrial Robot – Types – Robot safety and Hardware - Industrial Automation Versions - Control elements of Industrial Automation- IEC/ ISA Standards for Control Elements - Motion control in automation - Selection of motor for automation system – sizing: importance of sizing, sizing of motor for a specific application - selection of mechanical components. Case studies of manufacturing automation and Process automation.

Total:45 Hours

TEXTBOOKS:

1. W. Bolton, —Programmable logic controllers, Elsevier Ltd, 2015.
2. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book co, 1987

REFERENCES:

1. Frank D Petruzella, —Programmable logic controllers‖, McGraw-Hill, 2011.
2. Carl D. Crane and Joseph Duffy, "Kinematic Analysis of Robot manipulators", Cambridge University press, 2008
3. Aaron Martinez and Enrique Fernandez, —Learning ROS for Robotics Programming‖, PACKT Publishing, 2013.
4. Mitsubishi Electric India PLC, SERVO, VFD & ROBOTICS Programming Manuals.