H.K.E.SOCIETY'S

POOJYA DODDAPPA APPA COLLEGE OF ENGINEERING, GULBARGA

Electronics and Instrumentation Engineering Branch

(Applicable for 2018-19 admitted batch)

SCHEME OF TEACHING AND EXAMINATION

VII SEMESTER

Code No.	Course	Hours / Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CIE	SEE	Total
SEMESTER VII								
THEORY								
19EI71	Industrial Automation	03	00	00	03	50	50	100
19EI72	Instrumentation Project Engineering	03	00	00	03	50	50	100
19EI73	Internet of Things and Applications	03	00	00	03	50	50	100
19EI74X	Elective-3	03	00	00	03	50	50	100
19EI7OEX	Open Elective-2	03	00	00	03	50	50	100
PRACTICAL								
19EIL71	Programmable Logic Control Lab	00	00	02	01	50	50	100
19EIL72	Internet of Things Lab	00	00	02	01	50	50	100
19EI7S1	Seminar*/Case study/ Group work			02	01	50	--	50
19EI7P1	Project Work Phase - I**	00	00	02	02	50	50	100
	Internship	To be carried out during the intervening vacations of VII and VIII semester.						
				TOTAL	**20**	**450**	**400**	**850**

CIE - Continuous Internal Evaluation, SEE – Semester End Examination

*** Students have to give seminar on the current topic**

**** Students have to submit their project synopsis and give seminar on the project topic**

ELECTIVE - 3

1	19EI741	Biomedical Signal Processing
2	19EI742	Digital Image Processing
3	19EI743	Mechatronics

OPEN ELECTIVE -2

1	19EI7OE1	VLSI Design
2	19EI7OE2	Biomedical Instrumentation

Course Title: Industrial Automation		
Course Code:	19EI71	CIE: 50
Number of Lecture Hours/Week	3 Hrs (Theory)	SEE: 50
Total Number of Lecture Hours	42 Hours	SEE Hours:03
Prerequisite: **Control Systems and Industrial data commutation and network**		

Course Objectives

1. To make the students understand the fundamentals of communication network, PLC architecture, hardware components.
2. To make the students understand basic PLC programming.
3. Appreciate the role of ladder programming in automation industry.
4. Understand the concept of SCADA communication.
5. To study the DCS organization and operation.

Modules	**Teaching Hours**
Module I **Introduction to Industrial Networking:** overview of RS 232- 422-423-485 standards. Industrial field buses MODBUS – Serial, PROFIBUS-DP, Foundation fieldbus , HART Communication Network and TCP/IP. **Programmable Logic Controllers:** Introduction, Internal Architecture of PLC, Principles of Operation,PLCs versus Computers, PLC Size and Application. **PLC Hardware Components:** I/O section: Discrete I/O modules, Analog I/O modules, Special I/O modules, I/O specifications, The CPU operation, memory design, memory types, programming terminal devices, recording and retrieving data, human machine interfaces (HMIs).	**08 Hrs**
Module II **Basics of PLC Programming:** Processor memory organization, program scan, PLC programming languages, relay type instruction, instruction addressing, branch instructions, internal relay instructions, programming examine if closed and examine if open instructions, entering the ladder diagram, modes of operation. **Developing fundamental PLC wiring diagrams and ladder logic programs:** Electromagnetic control relay, contractors, motor starters, manually operated switches, mechanically operated switches, sensors, output control devices, Seal-In circuits, latching relays, converting relays schematics into PLC ladder programs, writing a ladder logic programs directly from a Narrative description. **Instruction set :** **Data manipulation instruction:** Data manipulation, data transfer operation, data compare instruction, data manipulation programs.	**08 Hrs**
Module III **Math instruction instructions:** Arithmetic operations and Boolean	

operations. **Programming timers:** Mechanical timing relays, timer instructions, ON-Delay timer instruction, Off-Delay timer instruction, retentive timer, cascading timers. **Programming counters:** Counter instructions, Up-counter, Down-counter, cascading counters, incremental encoder-counter applications, counter based timer function.	**10 Hrs**
Module IV **Sequence and shift resistor instruction:** Mechanical sequencer, sequencer instructions, sequencer programs, bit shift registers, word shift operations. **SCADA**: Introduction, brief history of SCADA, elements of SCADA. Features of SCADA, HTU-functions of HTU, RTU-function of RTU, protocol detail. SCADA as real time system communications in SCADA types and method used, components, protocol structure medium used for communications.	**08Hrs**
Module V **Distributed Control System** (**DCS**) Introduction to DCS, Evolution of DCS, DCS flow sheet symbols, architecture of DCS, Controller, Input and output modules, Communication module, data highway, local I/O bus, Workstations, Specifications of DCS. **DCS System integration with PLCs:** HMI, Man machine interface sequencing, Supervisory control, and integration with PLC, personal computers and direct I/O, serial linkages, network linkages, link between networks, Interface between DCS-PLC-ESD(Emergency shutdown system) and Triple Modular redundant (TMR)-PLC/ESD.	**08 Hrs**

Question paper pattern:
Total 10 questions will be asked. Two from each module. The student has to answer five questions selecting at least one from each module.

Text books:

1. PLC and SCADA - Rajesh Mehra, Vikrant Vij, Laxmi Publication, ISBN:978-93-8159-11-8.
2. Instrument engineers handbook- Process control-Bela G. Liptak Chilton book company-3rd edition.

Reference Books:

1. PC Based Instrumentation: Concept and Practice – N. Mathivanan, PHI, 2007(ISBN 978-81-203-3076-4).
2. Programmable Logic Controllers by Thomas Hughes, ISA Publication.
3. Profibus PA Instrumentation Technology for Process Industry –Ch. Diedrich, Th. Bangmann.
4. Practical Industrial data Communication: Best Practice Technology- Deon Reynders, Steve Mockay Edvin. Uright-Elsevier Publication- ISBN 0-7506-6395-5.
5. Securing SCADA System-Ronald - L U Krutz, John Wiley and Sons, ISBN: 9780471787686.

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
19EI71	**CO1**	Analysis the concept of commutation Network, PLC architecture and Hardware.

	CO2	Describe basics of PLC Programming and fundamental PLC wiring diagrams.
	CO3	Develop the PLC Programs with different instruction set using ladder diagram.
	CO4	Analysis the elements and features of SCADA system.
	CO5	Illustrate the concept of DCS and its integration with other systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1							2	3	3	
CO2	3	2	3	1	1							1	3	3	
CO3	3	2	3	1	1							1	3	3	
CO4	3	2	3	1	1							1	3	3	
CO5	3	2	3	1	1							2	3	3	

Course Title: **Instrumentation Project Engineering**		
Course Code	19EI72	CIE: 50
Number of Lecture Hours/Week	3 Hrs (Theory)	SEE: 50
Total Number of Lecture Hours	42 Hours	SEE Hours:03

Prerequisite: Process Control (16EI53)

Course Objectives

1. To learn and understand basic Instrumentation system design and related standards
2. To learn and understand concept of grounding and shielding, EMI/EMC and ESD effects.
3. To learn and understand application based ICS.

Modules	**Teaching Hours**
Module I **Standards used in instrumentation project**: ISA, ANSI, ASTM, ASME, NEPA, NEMA. **Project documents-** Need for engineering documents, general guidelines for development of documents, project stage, purpose, scope, contents, reference for document, team for creation and users. **Major project documents:** 1. Process flow diagram 2. Panel drawing and specification 3. Instrumentation index sheet 4. Instrument specification sheet for temperature, pressure, level, flow instruments and control valves. 5. Instrument location plan 6. Cable and tray routing 7. Cable schedule 8. JB schedule 9. Project Procedures 10. Project Schedule and Project Manager	. **10 Hrs**
Module II **Basic concept of instrument design** Functional requirements and instrument specifications, Basics of standards used, NEMA and IP standards with special reference to packaging standards, operational environment, prototype and testing.	**08 Hrs**
Module III **Guidelines for enclosure, compactness and accessories.** Grounding and shielding techniques, Noise in electronic circuits, EMI &EMC effects, minimization methods, ESD, Protection against ESD, control panel layout, ergonomics and aesthetics.	**08 Hrs**
Module IV **Design of control valve:** Review of flow equations, valve selection and sizing for liquid service, gas or vapuor service, flashing liquids, mixed phase flow. Control valve cavitations, actuator sizing. Design of safety relief valves and rupture discs.	**08 Hrs**

Module V	
Design of control panel: Control room layout, Electrical power systems. Instrument power requirement, instrument power distribution. Control room lighting, communication systems, Electrical classifications. Control panel types. Flat faced panels, break front panels, consoles. Comparison of panel types, panel layout, face layout, rear layout, auxiliary racks and cabinets. Panel piping and tubing, air headers, tubing runs, panel wiring, nameplates and tags. Painting and graphic displays. Panel bid specifications, panel inspections.	**08 Hrs**

Question Paper Pattern: Total 10 questions will be asked. Two from each module. The student has to answer five questions selecting at least one from each module.

Text books:

1. Instrument Engineers Hand Book-Process Control - Bela G Liptak, Chilton company , 3rd edition,1995
2. Applied Instrumentation in the Process Industries - W.G.Andrew, H.B.Williams, Vol-II second edition, practical guidelines.

Reference Books:

1. Successful Instrumentation and Control System design - Michael. D. Whit, ISA publication

2. Installation of Instrumentation and Process Control Systems - EE UAH book

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
19EI72	**CO1**	Describe Instrumentation project documents.
	CO2	Explain about basic concept of instrument specification and standards.
	CO3	Demonstrate the knowledge of grounding and shielding techniques.
	CO4	Demonstrate the knowledge of control valves cavitations and actuator sizing.
	CO5	Plan for design of control panel and its layout.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1											3		
CO2	3	2	2										3	2	
CO3	3	3	2										3	2	
CO4	3	2	1										3	2	
CO5	3	1	2										3	2	

Course Title: Internet of Things and Applications		
Course Code	19EI73	CIE: 50
Number of Lecture Hours/Week	03 Hrs.(Theory)	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03

Prerequisite: Industrial Data Communication and Networking.

Course Objectives :

1. Assess the genesis and impact of IoT applications, architectures in real world.
2. Illustrate diverse methods of deploying smart objects and connect them to network.
3. Compare different Application protocols for IoT.
4. Infer the role of Data Analytics and Security in IoT.
5. Identify sensor technologies for sensing real world entities and understand the role of IoT in various domains of Industry.

Modules	Teaching Hours
Module I What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.	**08 Hrs**
Module II Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies.	**08Hrs**
Module III IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods.	**08Hrs**
Module IV Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment	**09Hrs**
Module V IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino Programming. IoT Physical Devices and Endpoints RaspberryPi: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi	**09Hrs**

Question paper pattern:

Total 10 questions will be asked. Two from each module. The student has to answer five questions selecting at least one from each module.

Text Books

1. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Thing - David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, 1stEdition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
2.Understanding smart sensors, randy Frank, second Edition, artech house Publications 2000

Reference Books:

1. Internet of Things (A Hands-on-Approach) - Vijay Madisetti and ArshdeepBahga, 1stEdition, VPT, 2014. (ISBN: 978-8173719547)
2. Internet of Things - CENGAGE Srinivasa K G, Leaning India, 2017
3. Internet of Things: Architecture and Design Principles - Raj Kamal, 1st Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224)

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
19EI73	**CO1**	Interpret the impact and challenges posed by IoT networks leading to new architectural models.
	CO2	Compare and contrast the deployment of smart objects and the technologies to connect them to network.
	CO3	Appraise the role of IoT protocols for efficient network communication.
	CO4	Elaborate and the need for data analytics and security.
	CO5	Illustrate different sensor technologies for sensing real world entities and identify the applications of IoT in Industry.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3						1	2	2	2	
CO2	3	3	3	1	3						1	2	2	2	
CO3	3	2	3	1	3						1	2	2	2	
CO4	3	2	3	2	3						1	2	2	2	
CO5	3	2	3	1	3						1	2	2	2	

Course Title: Biomedical Signal Processing		
Course Code	19EI741	CIE: 50
Number of Lecture Hours/Week	3 Hrs (Theory)	SEE: 50
Total Number of Lecture Hours	42 Hours	SEE Hours:03
Prerequisite: Biomedical Instrumentation (16EI52), Digital Signal Processing (16EI51)		

Course Objectives

1. To understand the nature and characteristics of Biomedical signals.
2. To understand the effects of artifacts on the signals.
3. To provide the knowledge of signal averaging techniques.
4. To understand concepts of different data compression techniques.

Modules	Teaching Hours
Module I **Introduction:** The nature of biomedical signals, classification of biomedical signal analysis, objectives of biomedical signal analysis, difficulties encountered in biomedical signal, Computer aided diagnosis. Neurological Signal processing: Brain and its potentials, Electrophysiological, Origin of Brain waves, EEG signal and its characteristics, Sleep EEG , Abnormal EEG Epilepsy, EEG Analysis.	. **09 Hrs**
Module II **Filtering for Artifacts Removal:** Random noise, structured noise and physiological interference, stationary versus non-stationary processes, typical case study, time domain filters with application: Synchronized averaging, moving-average filters. Frequency domain filters with examples, removal of high frequency noise by Butterworth low pass filters, removal of low frequency noise by Butterworth high pass filter, removal of periodic artifacts by notch and comb filters. Weiner filter.	**09 Hrs**
Module III Basics of signal averaging: Signal averaging as a digital filter, A typical average, Software for signal averaging, Limitations of signal averaging. ECG QRS detection techniques, ST segment analysis, arrhythmia analysis, arrhythmia monitor.	**08 Hrs**
Module IV ECG Parameters and their estimation, Principle of an adaptive filter, the steepest descent algorithm, Adaptive noise canceller, Cancellation 60Hz Interference in ECG, Cancelling Donor heart Interference in Heart-transplant, ECG Cancellation of Electrocardiographic signals from the electrical activity of chest muscles, Cancelling of maternal ECG in Fetal ECG, Cancellation of higher frequency noise in electro-surgery.	**08 Hrs**
Module V Direct data compression techniques, Direct ECG data compression techniques, Transformation compression techniques, Other data compression techniques,	**08 Hrs**

Data compression techniques comparison.	

Question paper pattern:

Question Paper Pattern: Total 10 questions will be asked. Two from each module. The student has to answer five questions selecting at least one from each module.

Text books:

1.Biomedical signal analysis- A case study approach - Rangayyan Rangaraj, Wiley Interscience (IEEE Press)-2005

2. Biomedical Signal Processing- principles and techniques, Tata McGraw-Hill, D.C.Reddy, 2005

3.Biomedical Digital Signal Processing-Willis J. Tompkins, PHI.

Reference Books:

1. Biomedical Signal Processing - Akay M, , Academic: Press 1994.

2. Biomedical Signal Processing - Cohen.A, -Vol. I Time & Frequency Analysis, CRC Press, 1986.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
19EI741	**CO1**	Discuss the origin, nature and characteristics of biomedical signals.
	CO2	Identify the noise and artifacts in biomedical signals and apply suitable filters to remove artifacts.
	CO3	Apply the signal averaging technique and QRS complex detection techniques.
	CO4	Evaluate various event detection techniques for the analysis of the EEG and ECG.
	CO5	Apply different data compression techniques on biomedical Signals.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1			2							2		3	2
CO2	3	2			2							3		3	2
CO3	3	2			2							2		3	2
CO4	3	2			2							2		3	2
CO5	3	1			2							2		3	2

Course Title: Digital Image Processing		
Course Code	19EI742	CIE: 50
Number of Lecture Hours/Week	03 Hrs.(Theory)	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Prerequisite:		

Course Objectives

1. To understand the fundamentals of digital image processing
2. To understand the image transform used in digital image processing
3. To understand the image enhancement techniques used in digital image processing
4. To understand image restoration techniques and methods used in digital image processing

Modules	Teaching Hours
Module I Digital Image Fundamentals: What is Digital Image Processing?, Origins of Digital Image Processing, Examples of fields that use DIP, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations.	**08 Hrs**
Module II Spatial Domain: Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters. Frequency Domain: Preliminary Concepts, The Discrete Fourier Transform (DFT) of Two Variables, Properties of the 2-D DFT, Filtering in the Frequency Domain, Image Smoothing and Image Sharpening Using Frequency Domain Filters, Selective Filtering.	**08 Hrs**
Module III Restoration: Noise models, Restoration in the Presence of Noise only using Spatial Filtering and Frequency Domain Filtering, Linear, Position Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering.	**08 Hrs**
Module IV Color Image Processing: Color Fundamentals, Color Models, Pseudo color Image Processing. Wavelets: Background, Multi resolution Expansions. Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, the Hit-or-Miss Transforms, Some Basic Morphological Algorithms.	**10 Hrs**
Module V Segmentation: Point, Line, and Edge Detection, Thresholding, Region Based Segmentation, Segmentation Using Morphological Watersheds. Representation and Description: Representation, Boundary descriptors.	**08 Hrs**

Question paper pattern:

Total 10 questions will be asked. Two from each module. The student has to answer five questions selecting at least one from each module.

Text Books:

Reference Books:

1. Digital Image Processing- Rafel C Gonzalez and Richard E. Woods, PHI 3rd Edition 201
2. Digital Image Processing- S.Jayaraman, S.Esakkirajan, T.Veerakumar, Tata McGraw Hill 2014
3. Fundamentals of Digital Image Processing-A. K. Jain, Pearson 2004

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
19EI742	**CO1**	Understand image formation and the role human visual system in perception of gray and color image data.
	CO2	Apply image processing techniques in both the spatial and frequency (Fourier domains)
	CO3	Analysis of image restoration techniques.
	CO4	Conduct study of color image processing by morphological algorithms
	CO5	Design image analysis techniques in the form of image segmentation and to evaluate the methodologies for segmentation.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2							3		3	2
CO2	3	3	2	2	2							3		3	2
CO3	3	3	2	2	2							3		3	2
CO4	3	3	2	2	2							3		3	2
CO5	3	3	2	2	2							3		3	2

Course Title: Mechatronics		
Course Code	19EI743	CIE: 50
Number of Lecture Hours/Week	3 Hrs (Theory)	SEE: 50
Total Number of Lecture Hours	42 Hours	SEE Hours:03
Prerequisite: Transducers and Instrumentation (16EI35), Digital System Design (16EI33).		

Course Objectives

1. Understanding of mechatronic systems.
2. To understand the use of sensors and transducers for different mechatronic applications.
3. To identify and solve faults in mechatronic systems.
4. To design modular system and perform validation.

Modules	Teaching Hours
Module I **INTRODUCTION:** What is Mechatronics? Systems, Measurement systems, Control systems, Microprocessor-based controllers, response of systems, The mechatronics approach. **SENSORS AND TRANSDUCERS:** Sensors and transducers, Performance terminology, Displacement, position and proximity, Velocity and motion, Force, Fluid pressure, Liquid flow, Liquid level, Temperature, Light sensors, Selecting of sensors, Inputting data by switches.	. **09 Hrs**
Module II **PNEUMATIC AND HYDRAULLC ACTUATION SYSTEMS:** Actuation systems, Pneumatic and hydraulic systems, Directional control valves, Pressure control valves, Cylinders, Process control valves, Rotary actuators. **MECHANICAL ACTUATION SYSTEMS:** Mechanical systems, Types of motion, Kinematic chains, Cams, Gear trains, Ratchet and pawl, Belt and chain drives, Bearings, Mechanical aspects of motor selection.	**09 Hrs**
Module III **ELECTRICAL ACTUATION SYSTEMS:** Electrical systems, Mechanical switches, Solid-state switches, Solenoids, D.C. motors, A.C. motors, Stepper motors. **PRINCIPLES OF FEEDBACK AND INTELLIGENT CONROL:** Introduction, Control Systems, control, The controllers, More about automatic control, Defining automatic control methods, Artificial Neural Network, Fuzzy Logic, Diagnostics, Analog Versus Digital Control.	**08 Hrs**
Module IV **INTEGRATION:** Introduction, Background, Advanced actuators, Consumer mechatronic products, Hydraulic fingers, Surgical equipment, Industrial Robot, Autonomous Guided Vehicle (AGV), Drilling machine.	**08 Hrs**
Module V **FAULT FINDING:** Fault-detection techniques, Watchdog timer, Parity and error coding checks, Common hardware faults, Emulation and simulation	**08 Hrs**

Question paper pattern:

Total 10 questions will be asked. Two from each module. The student has to answer five

questions selecting at least one from each module.

Text books:

1. Mechatronics – W. Bolton, Pearson Education Asia -3rd Edition (Unit 1-5, and 8) 1999.
2. Mechatronics: Principles, Concepts and applications – Nitaigour and Premchand, Mahilik – TMH, 2003 (unit 6 & 7).

Reference Books:

1. Introduction to Mechatronics and Measurement Systems –David G. Alciatore & Michel BiHistand, Tata McGraw Hill –2000.
2. Mechatronics – H.D. Ramachandra – Sudha Publication -2003 Mechatronics by HMT Ltd. – Tata McGraw-Hill, 2000.
3. Mechatronics System design by Devadas Shetty and Richard A. Kark, Thomas Learning, 1997.
4. Mechatronics an Introduction by Robert H Bishop, CRC, 2005.
5. Mechatronics Systems Fundamentals by Rolf Isermann, Springer, 2000.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
19EI743	**CO1**	Describe the functioning of different sensors and transducers.
	CO2	Demonstrate the knowledge of pneumatic, hydraulic and mechanical actuation systems.
	CO3	Discuss different electrical actuation systems.
	CO4	Illustrate the principles of feedback and intelligent control systems.
	CO5	Use fault finding techniques.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		2								2	3		2
CO2	3	2		2	2							2	3		2
CO3	3	2	3	2	1							2	3		2
CO4	3	2		2	1							2	3		2
CO5	3	2	3	2	1							2	3		2

Course Title: **VLSI Design**		
Course Code	19EI7OE1	CIE: 50
Number of Lecture Hours/Week	03 Hrs (Theory)	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Prerequisite: Analog Electronics (16EI32), Digital System Design (16EI33).		

Course Objectives

1. To impart the basic knowledge of semiconductor, crystal and doping level and formation and behavior of PN junction.
2. To impart concepts and structure of MOS and CMOS, BiCMOS transistor.
3. To understand the fabrication process of MOS and CMOS transistors.
4. To understand the electrical properties of MOS transistors and inverters using MOS, CMOS, and BICMOS.
5. To acquire basic concept of MOS and BiCMOS circuits design layout process.
6. To discuss about the various methodologies inVLSI design.

Modules	**Teaching Hours**
Module I **Semiconductor and Monolithic Devices :** Semiconductor bonds in semiconductor crystals, commonly used semiconductors, energy band description, effect of temperature, hole electronic current, Intrinsic and extrinsic semiconductors, n-type and p-type semiconductors, charge carriers in pn junction, properties of pn junction, volt-ampere characteristics of pn junction. Basic structure and VI characteristics of Bipolar transistor, BiCMOS transistors, MOSFET transistors both in enhancement mode and depletion mode of operation.	**09 Hrs**
Module II **Integrated Circuits:** Advantages and disadvantages of integrated circuits, classification of integrated circuits, Fabrication of Integrated circuits, simple monolithic ICs, IC packings, IC symbols, scale of integration. **Fabrication to MOS technology:** Fabrication process of Nmos transistors, CMOS transistors fabrication, the p-well process, the n-well process, the twin tub process, BiCMOS transistor, BiCMOS fabrication in n-well process, Comparison between bi-polar and CMOS devices.	**09 Hrs**
Module III **Basic Electrical Properties of MOS circuits**: Drain to source current I_{ds} versus voltage V_{ds} relationships. Aspects of MOS transistor threshold voltage V_T. The pass transistor, nMOS inverter, determination of pull-up to pull-down ratio Z_{pu}/Z_{pd} for nMOS inverter, alternative forms of pull-ups of MOS transistors, the CMOS inverter, BiCMOS inverters and its alternative forms.	**(08 Hrs**
Module IV **MOS & BiCMOS circuit design processes**: MOS layers, Stick diagrams, nMOS design style, CMOS design style, Design rules and layout, λ based design rules, contact and cuts, double metal MOS process rules, CMOS λ based design rules, general observations on the design rules. Design of layout diagrams for various logic gates such as inverters, NAND, AND, OR, NOR etc.	**08 Hrs**

Module V	
Introduction to historical perspective: Moore's law, integrated circuit (IC) era, speed power performance in IC technology, overview of VLSI design methodologies, VLSI design flow, design hierarchy, concepts of regularity, modularity and locality; VLSI design styles, design quality, packing technology, computer aided design technology.	**08 Hrs**

Question paper pattern:
Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Text books:
Basic VLSI Design, Douglas - A Pucknell, Karman Eshragaian, PHI, 2005.

Reference Books:
1. Principles of CMOS VLSI Design- Neil H. Weste, Karman Eshragaian.
2. Introduction to VLSI Design, Mead & Convay, Addison Wesley)VLSI Engineering, Thomas Dillinger, PHI.
3. CMOS Digital Integrated Circuits analysis and design, Sung-Mo-Kang, TMH, 3rd Edition.
4. VLSI Technology, S.M. Sze, Tata McGraw Hill 2nd Edition.

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
19EI7OE1	**CO1**	Describe the doping of semiconductor and behavior of PN junction.
	CO2	Describe the structure and operation of MOS, CMOS, BICMOS transistors.
	CO3	Demonstrate the fabrication process of Monolithic, MOSFET, CMOS and BiCMOS transistor.
	CO4	Design inverter circuit for MOS, CMOS, BiCMOS transistors.
	CO5	Design the circuit layout design of MOS, CMOS transistors using stick diagrams**.**
	CO6	Explain various VLSI design methodologies**.**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	POS2	PSO3
CO1	2	1	2									1	3	3	
CO2	3	2										3	3	3	
CO3	3	3	3									3	3	3	
CO4	3	3	2	2								3	3	3	
CO5	3	3	3	2	1	1		1	1	2	2	3	3	3	3

Course Title: Biomedical Instrumentation		
Course Code	19EI7OE2	CIE: 50
Number of Lecture Hours/Week	03 Hrs (Theory)	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03
Prerequisite: Transducers and Instrumentation (15EI35)		

Course Objectives

The students are made to understand:

1. Different sources of biomedical signals.
2. Different biomedical signal recorders.
3. About the blood flow and cardiac output measurements.
4. Operation of cardiac pacemakers, defibrillators and therapeutic equipments.

Modules	Teaching Hours
Module I **Fundamental Concepts:** Sources of biomedical signals, Basic medical instrumentation system, performance requirements of medical instrumentation systems, PC based medical instruments, General constraints in design of medical instrumentation systems. Bioelectric Signals and Electrodes: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG) and Electrodes for ECG, EEG, EMG**.**	**09 hrs**
Module II **Recorders:Electrocardiogram**:Review of Heart Structure & Function, Conduction System of the heart, Electrical activity of the heart, Genesis & characteristics of Electrocardiogram (ECG), Electrocardiogram (ECG), Characteristics of the normal ECG, Cardiac arrhythmias and their electrocardiographic interpretation-Abnormal sinus rhythms, Premature contractions, description of an Electrocardiograph, ECG lead system, ECG recorder. **Electroencephalograph**:Genesis of Electroencephalogram (EEG), Block diagram description of an Electroencephalograph, 10-20 electrode systems, and computerized analysis of EEG.	**09 hrs**
Module III **Blood Flow And Cardiac Output Measurement:** Measurement of blood pressure Direct & Indirect method measurement of systolic, diastolic blood pressure, Detection of Kortokoff sounds, Laser Doppler flow meters. Cardiac output measurement: Indicator dilution method, Dye dilution method. Thermal dilution techniques, Measurement of continuous cardiac output derived from the aortic pressure waveform, Impedance technique.	**08 hrs**

Module IV **Cardiac Pacemakers And Defibrillators:** Need for cardiac pacemaker, External pacemaker, Implantablepacemaker, Ventricular synchronous demand pacemaker, Programmable pacemaker, Rate-responsive pacemakers, Packaging, Power sources, Leads & electrodes and their problems. Defibrillators-Need, DC defibrillator Electrodes, DC defibrillator with synchronizer, Automatic external defibrillator, Implantable defibrillator, Defibrillator analyzer	**08 hrs**
Module V **Bio Telemetry& Physiotherapy Equipments:** Biomedical Telemetry & Telemedicine: Wireless telemetry, single channel telemetry, multi-patient telemetry, implantable telemetry and telemedicine. High frequency heat therapy, short wave, microwave diathermy, ultrasonic therapy unit, electro diagnostic therapeutic aperaturs, pain relief through electrical simulation.	**08 hrs**

Question paper pattern:

Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Text books:

1.Hand book of Biomedical Instrumentation - R. S. Khandpur, 2ndEdition, Tata McGraw Hill, 2003.

2.Biomedical Instrumentation and Measurement - Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, 2nd Edition, Prentice-Hall India Pvt. Ltd., 2004.

Reference Books:

1. Medical Instrumentation Application & Design - John G. Webster, 3rdEdition, John Wiley & Sons/Wiley Student Edition, 2001.

2. Principals of applied Biomedical instrumentation - LESLEY CROMWELL & OTHERS, John Wiley and sons, 2nd edition.

3. Introduction to Biomedical equipment technology - JOSEPH J CARR, JOHN M BROWN, Prentice hall of India, 4th Edition

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
19EI7OE2	**CO1**	Demonstrate the concept of biomedical signals, medical instruments and bio potential electrodes.
	CO2	Explain the characteristic of ECG,EEG, and concept of recorders.
	CO3	Demonstrate the principle of Blood pressure and blood flow and cardiac output measurement.
	CO4	Describe the concept of cardiac pacemakers and defibrillators.
	CO5	Describe the principle of assist devices, therapeutic equipment and biotelemetry.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	POS2	PSO3
CO1	3												3	1	
CO2	3												3	2	
CO3	3												3	1	
CO4	3	2	3										3	1	
CO5	3	1											3	1	

Course Title: Programmable Logic Control Lab		
Course Code	19EIL71	CIE: 50
Number of Practical Hours/Week	3 Hrs (Practical)	SEE: 50
		SEE Hours: 03

Prerequisite: Control system and IDC and Network

Course Objectives

Students will be able to

1. Understand the basic logic ladder programming
2. Understand the timer and counter functions used in PLC
3. Understand the interface of PLC with proximity sensor, LVDT and RTD

LIST OF EXPERIMENTS

Experiment on:

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1	Identify various parts and front panel status indicators of the given PLC.
2	Execute a ladder program to verify logical operations.
3	Study the operation of combinational circuits using PLC ladder diagram
4	Execute a ladder program to verify timer function blocks
5	Execute a ladder program to verify counter function blocks
6	PLC to test the START STOP logic for two inputs and one output and Develop/ test ladder program to blink LED/lamp
7	Measure temperature of the given liquid using RTD or Thermocouple and PLC.
8	Test ladder program for proximity sensor
9	Develop the ladder diagram for START and STOP of DC MOTOR using Latch.
10	Develop the ladder diagram of DC MOTOR with ON delay timer, OFF Delay timer and Pulse Timer
11	Study the operation of LVDT using PLC ladder diagram
12	Develop the ladder diagram for turning ON and OFF of DC motor using two proximity sensor

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)

		Students will be able to
19EIL71	**CO1**	Develop program using logical operations
	CO2	Develop program using Timers and counters
	CO3	Develop program for controlling DC motors
	CO4	Develop the program for interfacing proximity sensor, RTD And LVDT
	CO5	Develop the program for real time applications

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3						2	1		2	2	3	1
CO2	3	3	2			2			2	1		1	2	3	1
CO3	3	3	2	3		2			2	1		1	2	3	1
CO4	3	3		3		2			2	1		1	2	3	1
CO5	3	3				2			2	1		1	2	3	1

Course Title: Internet of Things Lab		
Course Code	19EIL72	CIE: 50
Number of Practical Hours/Week	3 Hrs (Practical)	SEE: 50
		SEE Hours:03

Prerequisite : Control system and IDC and Network

Course Objective

1. To enable the students to obtain the knowledge of Internet of things Lab in the following topics.
2. To focus on design and development of IoT enabled technologies which are cost effective and socially relevant.
3. To develop trained manpower (through student projects/research) in the field of IoT based application development

LIST OF EXPERIMENTS

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1	Study and Install IDE of Arduino and different types of Arduino
2	Write program using Arduino IDE for Blink LED
3	Write program using Arduino IDE for Controlling an Led with Push Button
4	Write program using Arduino IDE to Toggle LED using Push Button
5	Write program using Arduino IDE to Control of Lights using LDR Sensor
6	Write program to Control a relay switch by texting from your smartphone
7	Write program to Control Electronic Devices from anywhere using Mobile App
8	Write program to Study the Temperature sensor For monitoring temperature using Arduino.
9	Write program for Integrating Sensors & Reading Environmental Physical Valuesusing Arduino.
10	Study and Configure Raspberry Pi and Write a program for LED blink using Raspberry Pi.

Course outcomes: **On completion of the course, the student will have the ability to:**		
Course Code	**CO #**	**Course Outcome (CO)** **Students will be able to**
19EIL72	**CO1**	To demonstrate the concepts of Internet of thing
	CO2	To exhibit the skills of performing experimental tasks related to Internet of things in order to generate the necessary output
	CO3	To share the responsibility and contribute as a member of a team
	CO4	To analyze the data and interpret data to take valid decisions
	CO5	To prepare report about the experimental work

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3						1	2	2	2	
CO2	3	2	3	1	3						1	2	2	2	
CO3	3	2	3	1	3						1	2	2	2	
CO4	3	2	2	2	3						1	2	2	2	
CO5	2	2	3	1	3						1	2	2	2	

Course Title: Seminar * /Case Study/Group Work		
Course Code	19EI7S1	CIE: 50
Number of Practical Hours/Week	3 Hrs (Seminar)	SEE: 50
	--	SEE Hours:03

Course Objectives

1**.** To **c**onduct literature survey and select a seminar topic on current engineering developments.

2. To exhibit write up and presentation skills.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
19EI7S1	**CO1**	Identify significant and latest topics of electronics and instrumentation focusing on industrial and societal issues.
	CO2	Carryout the necessary survey for collection of information on specific topic selected for seminar.
	CO3	Perform self-study on selected topic and carryout critical analysis.
	CO4	Compile and make a technical report.
	CO5	Present seminar topic systematically.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1					2						3	2	2		
CO2	3										2	2	2		3
CO3	3										3	3	3		3
CO4									3						
CO5				2					3						

Course Title: Project Work Phase - I**		
Course Code	19EI7P1	CIE: 50
Number of Practical Hours/Week		SEE: 50
		SEE Hours:03
Prerequisite		

Course Objectives

1. To conduct literature survey to develop a prototype engineering project.
2. To develop a methodology to implement in selected project.
3. To prepare a concise synopsis.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
19EI7P1	**CO1**	Demonstrate the skill to form and work in a group to perform the selected task.
	CO2	Conduct the literature survey towards developing a project.
	CO3	Carryout the task of problem identification and formulation for project work.
	CO4	Devise a plan, develop concepts and identify methodologies to design solution for selected project within a time frame.
	CO5	Exhibit communication skills through oral presentation and report writing.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1									3		3				
CO2	3	3										2	3	3	
CO3		3										3		3	
CO4			3			2	2	1			2	3			3
CO5										3					