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RAICHUR UNIVERSITY

SYLLABUS
For
M.Sc. ELECTRONICS AND INSTRUMENTATION

I, II, III & IV Semesters

(Under CBCS & CGPA with effect from 2023-24 and onwards)

Department of Studies and Research in
INSTRUMENTATION TECHNOLOGY
Raichur University, Krishna Tunga campus, Yeragera - 584 133, RAICHUR
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Course Outline & Syllabus for Master of Science (M.Sc.) Electronics & Instrumentation under CBCS & CGPA

Semester	Code	Title of the Course	Semester Exam	IA	Total	L	T	P	Credits
First		**Hard Core**							
	HCT 1.1	Analog and Digital Electronics	**80**	**20**	**100**	**4**	**0**	**0**	**4**
	HCT 1.2	Fundamentals of Instrumentation	**80**	**20**	**100**	**4**	**0**	**0**	**4**
	HCT 1.3	Control Systems and MATLAB	**80**	**20**	**100**	**4**	**0**	**0**	**4**
		Soft Core (Any One)							
	SCT 1.1	(a) Microcontrollers and Applications (b) MATLAB & Applications	**80**	**20**	**100**	**4**	**0**	**0**	**4**
		Practical							
	HCP 1.1	Analog and Digital Electronics Lab	**40**	**10**	**50**	**0**	**0**	**2**	**2**
	HCP 1.2	Transducers and Signal Conditioners Lab	**40**	**10**	**50**	**0**	**0**	**2**	**2**
	HCP 1.3	Analysis of Control Systems using MATLAB	**40**	**10**	**50**	**0**	**0**	**2**	**2**
		Soft Core (Any One)							
	SCP 1.1	(a) Microcontrollers Lab (b) MATLAB Lab	**40**	**10**	**50**	**0**	**0**	**2**	**2**
		Mandatory skills							
		Communication Skills	-	-	-	-	-	-	**2**
		Total for First Semester	**480**	**120**	**600**	**16**	**0**	**8**	**26**

Semester	Code	Title of the Course	Semester Exam	IA	Total	L	T	P	Credits
Second		**Hard Core**							
	HCT 2.1	Introduction to VLSI Design	**80**	**20**	**100**	**4**	**0**	**0**	**4**
	HCT 2.2	Electrical & Electronic Instrumentation	**80**	**20**	**100**	**4**	**0**	**0**	**4**
	HCT 2.3	Advanced Microcontrollers and Embedded systems	**80**	**20**	**100**	**4**	**0**	**0**	**4**
		Soft Core (Any One)							
	SCT 2.1	(a) 'C' Language and Python Programming (b) AI in Instrumentation	**80**	**20**	**100**	**4**	**0**	**0**	**4**
		Open Elective (Any One)							
	OET 2.1	(a) Introduction to Electronic Instrumentation (b) Instrumentation for Physical and Life Sciences-I	**40**	**10**	**50**	**2**	**0**	**0**	**2**
		Practical							
	HCP 2.1	VLSI Design Lab	**40**	**10**	**50**	**0**	**0**	**2**	**2**
	HCP 2.2	Electric & Electronic Instrumentation Lab	**40**	**10**	**50**	**0**	**0**	**2**	**2**
	HCP 2.3	Advanced Microcontrollers and Embedded Systems Lab	**40**	**10**	**50**	**0**	**0**	**2**	**2**
		Soft Core (Any One)							
	SCP 2.1	(a) 'C' Language and Python Programming Lab (b) AI in Instrumentation LAB	**40**	**10**	**50**	**0**	**0**	**2**	**2**
		Mandatory skills							
		Computer Skills	**-**	**-**	**-**	**-**	**-**	**-**	**2**
		Total for Second Semester	**520**	**130**	**650**	**18**	**0**	**8**	**28**

Semester	Code	Title of the Course	Semester Exam	IA	Total	L	T	P	Credits
Third		**Hard Core**							
	HCT 3.1	Scientific /Analytical Instrumentation	**80**	**20**	**100**	**4**	**0**	**0**	**4**
	HCT 3.2	Process Instrumentation	**80**	**20**	**100**	**4**	**0**	**0**	**4**
	HCT 3.3	Biomedical Electronics	**80**	**20**	**100**	**4**	**0**	**0**	**4**
		Soft Core (Any One)							
	SCT 3.1	(a) Internet of Things (IoT) (b) Digital Signal Processors and Applications (c) Industrial components and system	**80**	**20**	**100**	**4**	**0**	**0**	**4**
		Open Elective (Any One)							
	OET 3.1	(a)Introduction to Microprocessors and Microcomputer (b) Instrumentation for Physical and Life Sciences-II	**40**	**10**	**50**	**2**	**0**	**0**	**2**
		Practical							
	HCP 3.1	Scientific /Analytical Instrumentation Lab	**40**	**10**	**50**	**0**	**0**	**2**	**2**
	HCP 3.2	Process Instrumentation Lab	**40**	**10**	**50**	**0**	**0**	**2**	**2**
	HCP 3.3	Biomedical electronics Lab	**40**	**10**	**50**	**0**	**0**	**2**	**2**
		Soft Core (Any One)							
	SCP 3.1	a) Internet of Things Lab (b) Digital Signal Processors and Applications Lab (c) Industrial components and system Lab	**40**	**10**	**50**	**0**	**0**	**2**	**2**
		Mandatory skills							
		Entrepreneurship Skills	-	-	-	-	-	-	**2**
		Total for Third Semester	**520**	**130**	**650**	**18**	**0**	**08**	**28**

Semester	Code	Title of the Course	Semester Exam	IA	Total	L	T	P	Credits
Fourth	HCMP 4.1	**Major Project/ Internship (400 for Project Evaluation and Dissertation +100 for Viva-voce + 100 for IA = 600 Marks)**	**500**	**100**	**600**	**0**	**0**	**24**	**24**
	IA marks distribution – Based on presentation/seminar/demonstration by the students for every month. **Internship is an extended period of work experience undertaken by the students to supplement their degree for professional development. Project work/ Internship must be carried out in the Industry/Organization/Parent Department or premier institutions like IISc, IITs or NITs. Student shall work for the project work/ Internship during the entire fourth semester (16 – 20 weeks) and submit a detailed Dissertation/ project report on the work carried out by him/her during the period to the Department for the partial fulfillment of the degree.** **The teaching staff shall guide the students in conceptualizing the project work, writing the Dissertation/ Research paper /Article and publishing in reputed journals. They shall also mentor the students by visiting the Industry/ Organization. The entire process may be Online/Offline/Hybrid mode** **University shall not bear any cost involved in carrying out the internship by students. However, students can receive any financial assistance extended by the organization. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent University examination after satisfying the internship requirements.**							

L= Lecture, T= Tutorials, P= Practical
4 Credits of Theory = 4 Hrs of Teaching per week 2 Credits of Practical = 4 Hrs per week
OE classes shall be conducted on every Friday from 2pm to 4pm

Study Tour: An academic/ industrial study tour of duration 08-10 days may be conducted during the vacations of II or III Semesters for students at their own cost.

Outcome of the course:

1. After the completion of M.Sc. (Electronics & Instrumentation) the students will be able to design/develop/fabricate various instruments.
2. The students will acquire the skills in teaching electronics and instrumentation subjects at UG/PG level
3. The students after completion of course, they can become entrepreneurs of electronic industries
4. The Students are ready for Research in Electronic and Instrumentation and Applied fields

I – SEMESTER

Course HCT 1.1: ANALOG AND DIGITAL ELECTRONICS

Teaching hours per week: 4 Total Hours: 64

Preamble:

A well-designed power supply is essential for any electronic circuit for proper functioning. Hence, this paper deals with the design and working of various power supplies and their individual sections. The paper also describes the basics of op-amps and their applications. The fundamentals of Digital electronics and various Digital devices and their operations are discussed. The units I and II are devoted for Analog electronics and units III and IV are devoted for Digital electronics.

UNIT I: Power Supplies and Regulation 16 Hrs

Block diagram of DC power supply. Rectifiers: Half - wave, Full – wave and Bridge. Filters: RC, LC, Π- sections. Voltage multipliers, DC voltage regulation: Zener, Discrete Component regulators and LM723 regulator. Three pin regulators. Switch Mode Power Supplies (SMPS). AC voltage regulation: Step voltage regulation and Servo voltage regulation. Invertors: Low tension DC to High tension AC or DC. Introduction to battery charger circuits – Battery Management systems and Applications. Noise signal in power supply and its elimination techniques.

UNIT II: Analysis of Operational Amplifiers 16 Hrs

Introduction to operational amplifiers (Op-Amps). Characteristics of ideal and practical operational amplifiers: Basic BJT differential amplifiers, Constant current source, Active load, Current mirror, Circuit details of typical operational amplifier circuits (μA741). Op- Amp-configurations, Mathematical operations, Solutions of second order differential equations, Wave form generation, Wein-bridge oscillator and multivibrators, Precision rectifiers and Instrumentation amplifier. Nano ampere – ultralow signal recovery techniques.

UNIT III: Digital Electronics 16 Hrs

Number systems and codes, Logic gates and Boolean algebra, Combinational logic circuits, Flip-Flops, Digital arithmetic operations – Half adder/subtractor, Full adder/subtractor, parallel adder/subtractor, BCD adder, Excess-3 adder/subtractor and circuits. Karnaugh Maps for simplification of logic circuits. Code converters, Encoders and Decoders. Multiplexers and Demultiplexers.

UNIT IV: Counters and Shift Registers 16 Hrs

Counters: Asynchronous (ripple) counter, counters with MOD numbers, IC Asynchronous counter, asynchronous down counters, propagation delay in ripple counters, synchronous (parallel) counters, synchronous down and up/down counters, Presettable counters, decoding a counter, decoding and latches, cascading BCD counters, Synchronous counter design. Registers: Serial-In serial-out, serial - in parallel out, parallel - in serial - out, parallel – in parallel out, shift registers. TTL logic family, TTL gates. Circuit design and analysis using simulators.

BOOKS FOR STUDY:

1. Linear Integrated Circuits – Sanjay Sharma
2. Linear Integrated Circuits - D Roy Choudhary & Shail Jain
3. Operational Amplifiers & linear Integrated circuits – Raviraj & Mohan Dudeja
4. Operational Amplifiers-Ramakant Gayakwad
5. Digital Systems –Principles & Applications –Ronaldo J Tocci & Meal S. Widmer
6. Digital Principles –Malvino & Leach
7. Fundamentals of Digital Circuits – A. Anandkumar

BOOKS FOR REFERENCE:

1. Operational Amplifiers and Characteristic- Robert G Irvine
2. Op-Amp and Linear Integrated Circuits – Robert F Caughlin

OUTCOME OF THE COURSE:

1. The Candidate understands the basic principles of analog and digital electronic devices, various circuits/systems and applications.

2. After studying this paper, the student can be able to design, analyse and fabricate various Analog and Digital Systems.

Course HCT 1.2: FUNDAMENTALS OF INSTRUMENTATION

Teaching hours per week: 4 Total Hours: 64

Preamble:

This paper deals with the fundamentals of instruments. Basics of instruments and their classification, characteristics are dealt. Transducers, signal conditioners and recorders with their features, working principle, advantages, limitations and applications are covered in this paper.

UNIT I: Instruments and their Classification 16 Hrs

Functional elements of Instrumentation and measuring systems, Typical Applications of instrument systems. Classification of instruments. Standards and calibrations. Microprocessor/PC based Instruments. Introduction to errors and uncertainties in the measurement. Propagation of uncertainties in compound quantities. Static Characteristics of Instrument. Specifications and selection of an instrument.

Unit 2- Transducers/ Sensors 16 Hrs

Analog Transducers: Resistive, Inductive, Capacitive, Piezoelectric transducers, Strain Gauges, Displacement transducer, Opto – electrical transducers. Digital Transducers. Microsensors – Silicon Microsensors, Smart sensors.

Unit 3 – Signal Conditioners 16 Hrs

Amplifiers: chopper stabilized DC amplifier, Isolation amplifier and Lock-in amplifier. Active filters – Low-pass, high-pass, band-pass, band-rejection and Second order Butterworth filter. Peak detector. Sample and hold circuit. Phase sensitive detector. A/D and D/A converters. Ultra-low level signal amplification.

Unit 4 – Recorders 16 Hrs

Digital voltmeter, CRO, Galvanometric recorder, Servo type of potentiometric recorder, Magnetic tape recorder, Digital recorders of memory type, electronic display devices: LED, LCD. Digital display: Dot matrix and Segmental display. Applications: Temperature and Humidity measurement systems. Systems design using simulators.

BOOKS FOR STUDY:

1. Instrumentation measurement & analysis –Nakra /Choudhary
2. Instrumentation devices & systems –Rangan, Mani, Sharma
3. A Course in mechanical measurements & instrumentation – A. K. Sawhney
4. Sensors and transducers – B. Patranabis

BOOKS FOR REFERENCE:

1. Measurement of systems—Application and design—Earnest O. Doeblin
2. Electronic instrumentation and measurement technique—W. D. Cooper & A. D. Helfrick.
3. Mechanical measurements – Beckwith, Marangoni.

OUTCOME OF THE COURSE:

1. The Candidate understands the Functional elements of an Instrument and types of Instruments also their characteristics.
2. Students will be able to appreciate the importance of static characteristics in designing/ selecting any instrument.
3. The students will be able to design and construct an Instrument to measure the parameters like Temperature, Pressure etc.…

Course HCT 1.3: CONTROL SYSTEMS AND MATLAB

Teaching hours per week: 4 Total Hours: 64

Preamble:

One of the important features of any instrument is to control the parameter. Hence, in this paper, the study of various control systems and transfer function approach or classical control theory for control system in time domain and frequency domain are dealt. Analysis of stability of a system by using RH criterion/ root locus in time domain and by using Bode plot/ Nyquist plot in frequency domain are covered. Study of MATLAB & Programming and application of MATLAB systems are dealt in detail in the last unit.

UNIT I: Introduction to Control Systems and Mathematical Modeling 16 Hrs

Control System: Open-loop and Closed-loop, Feedback and its effects, Mathematical Modeling - Differential Equation Approach to the Electrical systems, Mechanical system. Definition of Transfer function, Transfer function Approach to Physical System (Armature Controlled and field-controlled DC servo motor), Block Diagram Algebra. Signal flow-graphs.

UNIT II: Time Response Analysis, Stability Criterion and Root Locus Techniques 16 Hrs

Standard Test Signals, Time Response of first and second order systems. Design Specifications or Performance Indices of second order system. Static error coefficients. Concept of Stability. Routh-Hurwitz stability Criterion. Relative stability Analysis. Roots-Locus: Rules for construction, Root contours.

UNIT III: Frequency Response Analysis and Stability Criteria 16 Hrs

Introduction, Frequency response of first and second order systems, Correlation between time and frequency responses. Polar plots, Bode plots. Experimental determination of transfer functions from Bode plots. Nyquist stability criterion, Nyquist plots, Gain Margin (GM) and Phase Margin (PM). Concept of state variables and state models.

UNIT IV: MATLAB for Control systems 16 Hrs

MATLAB: Schematic diagram of MATLAB, MATLAB Toolboxes, MATLAB Windows, Common system commands and mathematical operations, Handling of Matrices, Writing the MATLAB programs for the analysis of control systems using Tool Boxes.

BOOKS FOR STUDY:

1. Control Systems Engineering – Nagrath. I. J. & Gopal M.
2. Automatic Control Systems- Benjamin C. Kuo
3. Modern Control System Engineering – K. Ogata
4. MATLAB for control systems – Dukkipat Rao

BOOKS FOR REFERENCE:

1. Feedback Control System Analysis & Design – D Azz, J. J. and Houpis C.H.
2. Control System Design – Savant C. J.
3. Basic Automatic Control Theory – Murphy G. J.

OUTCOME OF THE COURSE:

1. Able to do mathematical Modelling of Physical Systems.
2. Students will have the knowledge and skills to define control system, feedback control system and the importance of performance, characteristics/stability criteria in control system designing both in Time/Frequency domain.
3. Students will appreciate the importance of MATLAB Toolboxes in analysing control system Applications

Course SCT 1.1(a): MICROCONTROLLERS AND APPLICATIONS

Teaching hours per week: 4 Total Hours: 64

Preamble:

Microcontroller plays an important role in Instrumentation. Incorporation of microcontroller makes the system intelligent. Hence, this paper deals with the Architecture/ Instruction set/ Programming/ Interfacing of 8051 and PIC microcontrollers. Typical applications of 8051 and PIC microcontrollers are also dealt in the last unit.

UNIT I: 8051 Microcontroller Architecture 16 Hrs

Block diagram of 8051 microcontroller, Description of functional units of microcontroller, addressing modes, Classification of instructions set and programming, Comparative study of 8051 with 8031, 8751 and 89C51.

UNIT II: Interfacing of Peripherals 16 Hrs

Interfacing of memory (RAM & EPROM), Programmable peripherals 8155, 8755 and their interfacing, Interfacing of A/D & D/A converters. Interfacing of seven segment display, Multiplexed display, LCD module, Stepper motor with 8051 microcontroller.

UNIT III: Atmel Microcontroller Architecture, Programming and Interfacing 16 Hrs

Atmel architecture, instruction set, addressing modes, memory organization, ports, timers and counters, Interrupt controller, PWM, UART, USART, SPI, I2C, ADC, DAC, Watchdog timer, EEPROM, Comparator, USB, CAN, LCD controller, Ethernet controller, Programming of ATMEL microcontroller. Interfacing of LCD display, Ultrasonic sensor and generation of PWM waveform.

UNIT IV: Applications of Microcontroller for Measurement and Control 16 Hrs

Role of microcontroller in instrumentation, Application of microcontroller 8051 for measurement of frequency and time period of TTL signal. Measurement of thickness of an object through LVDT. Design and development of 8051 based electronic balance, temperature measurement and control system. Application of Atmel microcontroller for DC motor speed control.

BOOKS FOR STUDY:

1. The 8051 Microcontroller: Architecture, Programming and Applications –K. J. Ayala
2. The 8051 Microcontroller and Embedded Systems - Muhammad Ali Mazidi & J G Mazidi
3. Programming & customizing 8051 microcontroller -Myke Predko
4. Design with PIC Microcontrollers – John B. Peatman
5. Experiments with Microcontrollers – Dr. P. Bhaskar & Dr. K. Malakondaiah

BOOKS FOR REFERENCE:

1. MCS51 User Manual -Intel Corporation.
2. Embedded Microcontrollers Data Book- Intel Corporation.
3. PIC Microcontroller PIC87X Data mauel
4. Embedded Control Handbook - MICROCHIP (Vol. 1 & 2)

OUTCOME OF THE COURSE:

1. The students will understand the architecture, Instruction set, programming skills and Interfacing of different devices with microcontrollers
2. The students will be able to design and fabricate microcontroller-based systems for various applications
3. Students will understand the role of Microcontroller in Instrumentation.

Course SCT 1.1 (b): MATLAB AND APPLICATIONS

Teaching hours per week: 4 Total Hours: 64

Preamble:

This paper deals with the MATLAB and its structure, programming concepts, designing of Graphical user interface (GUI), creating models using SIMULINK, and also the typical applications of MATLAB in instrumentation in detail.

UNIT I: Introduction to MATLAB 16 Hrs

MATLAB: Schematic Diagram of MATLAB, MATLAB Toolboxes, MATLAB Windows, Common System Commands and Mathematical operations, Handling of Matrices, Handling of graphics, File Dialog Boxes.

UNIT II: MATLAB Programming 16 Hrs

Matrices and Arrays: Entering Matrices, Sum, Transpose and Diagonal, Subscripts, colon operator, Magic Function. Expressions: variables, numbers, operators, functions. Command window I\P &O\P: Format Function, Suppressing O\P, Entering Long Statements, Command Line Editing. Graphics: Plotting Techniques, Graph Components, Editing Plots, Basic Plotting Functions. Simulink.

UNIT III: Graphical User Interface 16 Hrs

Graphical User Interface, M-File Dialog boxes, Predefined Dialog Boxes, GUI Creations Fundamentals, GUI Development Environment, GUI Components, GUI Object Hierarchy, Capturing Mouse Actions.

UNIT IV: Application of MATLAB 16 Hrs

Application of MATLAB for simulation of various models, Designing of PID and Fuzzy Logic Controllers. Application of MATLAB for controlling rotational speed and angular position of DC motor.

BOOKS FOR STUDY:

1. MATLAB Programming- Y. Kirani Singh & B.B Chaudhury
2. Introduction to MATLAB- Gulati
3. Getting Started with MATLAB 7- Rudra Pratap
4.

BOOKS FOR REFERENCE:

1. An Introduction to fuzzy logic control- Driankov, H Hellendroon & M. Reifrank

OUTCOME OF THE COURSE:

1. Students will be Able to understand the ease of analysis of various systems by using MATLAB
2. Students will acquire knowledge to design various MATLAB simulation models

II – SEMESTER

Course HCT 2.1: INTRODUCTION TO VLSI DESIGN

Teaching hours per week: 4 *Total Hours: 64*

Preamble:

This paper deals with the different integrated circuit fabrication technologies with their comparison. The electrical properties associated with different technologies are described. Also, VLSI circuit design process and its related aspects are discussed. To fabricate/implement various logic circuits and to learn their implementation on ASIC are described. The devices such as PLDs, the CPLD and FPGA the generic architectures are discussed., finally by using EDA tool and writing VHDL code for the digital logic circuits and their implementation on CPLD/FPGA devices is covered.

UNIT I: Introduction to VLSI Technology 16 Hrs

Metal-Oxide Semiconductor (MOS) and related VLSI Technology. Basic MOS Transistors. Enhancement and Depletion Mode Transistor actions. CMOS fabrication. BiCMOS technology. Electrical Properties of MOS and BiCMOS Circuits: ID-VD Characteristics of MOS Transistor in Saturated and Non-saturated regions. MOS transistor Threshold voltage. Body-effect. The n-MOS inverter. Pull up and pull-down ratio for n-MOS inverter. Alternative forms of pull-up. CMOS inverter. BiCMOS inverters. Latchup in CMOS circuits.

UNIT II: VLSI Circuits Design Process 16 Hrs

VLSI Design flow, Layers of abstraction, Stick Diagram, Design goals and layout diagrams. Sheet resistance and Standard unit of capacitance. Inverter delays, Propagation delays, Wiring capacitance. Inverter Design aspects – Specifications considering worst-case parameters. Inverter in the input stage and output stage. Internal inverter.

UNIT III: Semi Custom Integrated Circuit Design 16 Hrs

Complex Programmable Logic Devices (CPLD) –Generic CPLD architecture and Generic Logic block, Xilinx XC9500 CPLD family – Function – Block Architecture, Input/ Output – Block Architecture, Switch Matrix. Field Programmable Gate Arrays (FPGA) –General structure, Interconnect, Switch technology Xilinx XC4000 FPGA family –Configurable Logic Block, Input Block, Programmable Interconnect. Application Specific Integrated Circuits (ASICs) –Types, Introduction about Full Custom and Semi Custom ASICs, General Description with respect to their Structures of Gate arrays, Standard Cells.

UNIT IV: System Design Using VHDL 16 Hrs

Introduction to VHDL: VHDL Description of Combinational Networks, Modeling Flip-Flops using VHDL, VHDL Models for Multiplexer, Compilation & Simulation of VHDL Code, Modeling Sequential Machine, Variables, Signals & Constants, Arrays, VHDL operators, VHDL Functions, VHDL Procedures, Packages & Libraries. VHDL for combinational circuits: Adder, Subtractor, Multiplexer, De-multiplexer, Encoder, Decoder, Flip-Flops, Registers, & Counters.

BOOKS FOR STUDY:

1. Basic VLSI Design, 3/e –D. A. Pucknell and K. Eshraghian, PHI, ND, 2006.
2. Digital systems design using VHDL – Charles H. Roth, Thomson Brooks/Cole, 2005.
3. Fundamentals of Digital Logic with VHDL Design – Stephen Brown and Zvonko Vranesic, TMH, ND, 2002.
4. Digital Electronics - Ronald Tocci.

BOOKS FOR REFERENCE:

1. Principles of CMOS VLSI Design. A System Perspective - N. Weste, K. Weste, K., Eshraghian-Addison-Wesley Publishing Co.
2. Digital Design -principles and practices - John F. Wakerly ,3rd Edition, Pearson Education

OUTCOME OF THE COURSE:

1. Students will be able to handle any type of CPLD/FPGA

2. Students will be able to understand limitations and capabilities of IC making.
3. Students will be able to develop their own libraries to develop specific application.
4. Students will be able to design and fabricate various digital systems using CPLD/FPGA devices

Course HCT 2.2: ELECTRICAL AND ELECTRONIC INSTRUMENTATION

Teaching hours per week: 4 Total Hours: 64

Preamble:

This paper deals with study of different types of electrical and electronic instruments with their principle and working. It also discusses the design and application of, Power and Energy meters, DC/AC Bridges, Digital measuring instruments such as multimeter, frequency meter, phase meter, function generators and waveform generators.

UNIT I: General Analog Measuring Instruments 16 Hrs

Permanent-magnet moving coil (PMMC) Galvanometer: Torque and deflection, PMMC Mechanisms, DC Ammeters, DC Voltmeters, Ohmmeters: serial and shunt types, extension of range of meters, multi-meters. AC meters: Electrodynamometers, rectifier type, thermo instruments.

UNIT II: Power & Energy Meters, Instrument Transformers, and Bridges 16 Hrs

Electrodynamometers in power measurements, Watthour meter, Power-factor meter, Instrument Transformers: Potential transformers and current transformers. DC Bridges: Wheatstone bridge, Kelvin bridge. AC Bridges: Maxwell bridge, Hay bridge, Schering bridge, Wein bridge.

UNIT III: Analog Measuring Instruments 16 Hrs

Electronic voltmeters (Transistor, FET & Op-Amp Versions), AC Voltmeters: Rectifier type, RMS voltmeters, AC milli/micro voltmeters, Nano-ammeter, Analog frequency meter, Analog phase meter, Cathode Ray Oscilloscope: Single beam, dual trace, dual beam.

UNIT IV: Digital Measuring Instruments and Wave Form Generators 16 Hrs

Digital voltmeters, Digital multimeter, Digital frequency meter, Digital phase meter, Q-meter, Digital storage oscilloscope and sampling oscilloscopes, Sine/Square wave generators, Radio frequency signal generator, Standard signal generator, function generator, Spectrum analyzer, Vector impedance meter.

BOOKS FOR STUDY:

1. Electronic Instrumentation and Measurement Techniques — William David Cooper & Albert D Helfriek.
2. Electronic Instrumentation - H S Kalsi
3. A Course In Electrical and Electronic Measurements and Instrumentation - A. K. Sawhney

BOOKS FOR REFERENCE:

1. Measurement of Systems—Application and Design — Earnest O Doeblin
2. Op-Amp and Linear Integrated Circuit –R F Coughlin, F F Driscoll
3. Hand Book of Biomedical Instrumentation –R S Khandpur (TMH)

OUTCOME OF THE COURSE:

1. Students understand the principle and working of various Electrical and Electronics instruments and their applications
2. Students are also able to design and develop various Electrical and Electronic Instruments viz. Ammeter, Voltmeter, Ohmmeter, Multimeter, Frequency meter, phase meter etc.....

Course HCT 2.3: ADVANCED MICROCONTROLLERS AND EMBEDDED SYSTEMS

Teaching hours per week: 4 Total Hours: 64

Preamble:

Embedded systems are systems which contain both computer like hardware and software and designed for a particular task. Now days embedded systems play an important role in day-to-day life. Hence, this paper deals with the embedded systems architecture/description of various elements/ classification / programming. Finally design and applications of some typical embedded systems are covered in this paper.

UNIT I: Cygnal C8051F020 Microcontrollers 16 Hrs

Cygnal C8051F020 microcontroller architecture, memory organization, description of functional units of microcontroller: ports, interrupts, on chip ADCs, DACs, serial peripheral interface, timers, programmable counter array. Comparative study of C8051F020 with C8051F060 and C8051F350. Programming and Applications.

UNIT II: ARM7 Microcontrollers 16 Hrs

ARM7 microcontroller architecture, memory organization, description of functional units of microcontroller: ports, interrupts, on chip ADCs, DACs, serial peripheral interface, timers, programmable counter array. Comparative study of ARM7 with ARM9 and ARM11 Programming and Applications.

UNIT III: Introduction to Embedded Systems 16 Hrs

Embedded systems, elements of embedded system, classification of embedded systems, application areas of embedded systems, purpose of embedded systems, embedded hardware and firmware design and development, RTOS based embedded system design: Operating system components- Kernel, tasks, process, threads, process management, memory management, task scheduling and task synchronization. Vx works/Micro C IDE.

UNIT IV: Typical Embedded Systems 16 Hrs

Microcontroller based temperature, level, pressure, flow control system. Microcontroller based DC motor speed control system and position and speed control system.

BOOKS FOR STUDY:

1. Embedded Systems Architecture, Programming and Design- Raj Kamal
2. Cygnal C8051F020/F060/F350 Data Manuals
3. Silabs IDE Manual
4. ARM7 data manual
5. Introduction to Embedded Systems – Shibu K V

BOOKS FOR REFERENCE:

1. Embedded Systems Design – Steve Heath
2. Embedded Systems - John B. Peatman.

OUTCOME OF THE COURSE:

1. The students understand the architecture/Instruction set/ Interfacing and applications of advanced microcontrollers.
2. The students understand the Embedded systems design and applications.
3. The students will be able to design and fabricate embedded systems using advanced microcontrollers.

Course SCT 2.1(A): 'C' Language and Python Programming

Teaching hours per week: 4 Total Hours: 64

Preamble:

This course deals with introduction to C language and Python programming. The basic programming structures of both the programming languages are discussed in details in this course.

UNIT I: Introduction to C language

Introduction to C language, Variables and Data types - Identifiers in C,Variables and Data Types, Constants. Console IO operations - Printf and Scanf, Unformatted IO Functions. Operators and Expressions - Expressions and Arithmetic Operators, Relational and Logical Operators, Bitwise Operators. Control flow statements - If Statement, Switch Statement, Unconditional Branching using goto statement, While Loop, Do While Loop, For Loop, Break and Continue, Special Cases. Working with functions - Introduction and Writing Functions, Scope of Variables, Storage classes, Pass by Value and reference, Recursion. Working with arrays - Arrays Declaration and Initialization, Sample Programs using Arrays, Arrays as Function Parameters, 2-Dimensional Array.

UNIT II: Pointers, Strings, Structures & Unions, File handling in C

Pointers - Introduction to Pointers, Pointers as Function parameter, Pointer Arithmetic, Pointers and Arrays, Function Pointers, Dynamic Memory Allocation using malloc, calloc and comparison with malloc. String Handling - Introduction to Strings, Sample Program, More Sample Programs, Standard String Library Functions, Array of String. Structures and Unions - Declaring and Instantiating Structures, Structure as Parameter and Pointer to Structure, Enumerated Data Type, Union, Bit Fields. File Handling - What is a Stream, File Handling-Writing and Reading Characters, Writing and Reading Structure in Text Format, Writing and Reading in Binary Format. Pre – processor directives - Understanding Pre-Processor directives, Header Files and Project. Command line arguments and variables – Arguments, Command Line Argument, Variable Number of Arguments

UNIT III: Introduction to Python programming

Introduction to python programming, Installing Python in Windows/Linux/Mac OS, Using Python interpreter, execute a Script, Structuring with Indentation, Editor. Data types and Variables – Variables, Variables v/s identifiers, Naming convention of variables, Keyword. Data Structure – List, Tuples, Sets, Dictionaries. Input And Output - Input function, Input with raw_input (), Output with old string format, Python format function. Control Flow - If/Else Statements, For/while Statements, Range () function, Break and continue statements, Else clauses on Loops.

UNIT IV: Functions, File & Error handling, Module and class in python

Functions - Defining Function, Default Argument, Keyword Argument, Arbitrary Arguments List. File Handling - Reading from the file, Writing to the file, Methods of file objects. Error And Expectation - Syntax Errors, Exceptions, Handling Exceptions (try, except). Module - Creating Modules, Import a module, Import the names, Executing modules as scripts. Class Concept - Class Syntax, Class Objects, Instance Objects, Method Objects, Class and Instance Variables. Advanced Modules - Regular Expressions, datetime - date and time libraries, Dealing with Excel, GUI, Web Scrapping

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BOOKS FOR STUDY:

1. Programming in C by E Bal Guruswamy.
2. C programming Absolute Beginner's Guide by Greg Perry
3. Core Python programming by Dr. R Nageshwara rao
4. Programming in python by R S Salaria

OUTCOME OF THE COURSE:

By the end of the course students will be able to

1. Understand the basic structure of programming language.
2. Write, compile and debug the 'C' and Python programs.

Course SCT 2.1(B): Artificial Intelligence

Teaching hours per week: 4 Total Hours: 64

Preamble:

This course serves as an introduction to the rapidly evolving field of Artificial Intelligence (AI). Which encompasses various techniques and technologies that enable machines to mimic certain aspects of human intelligence, including learning, reasoning, problem-solving, perception, and language understanding. This course provides a comprehensive overview of fundamental AI concepts, Artificial Neural Networks, Machine Learning and implement intelligent systems.

UNIT I: Introduction to Artificial Intelligence and Machine Learning 16 Hrs

Artificial Intelligence: Definition and History of AI, Types of AI – Narrow AI and General AI, Applications of AI in various field. Machine learning: Basic concepts of Machine Learning, Supervised, Unsupervised and Reinforcement learning, Key algorithms and their applications (Linear Regression, Decision Trees, k – Nearest Neighbors.

UNIT II: MATLAB ANN Tools 16 Hrs

Introduction to Neural Network architectures, Data preparation, Network Creation and Configuration, Training Algorithms, Transfer learning, Performance Evaluation, Visualization tools, Hyperparameter Tuning, GPU Acceleration, Integration with MATLAB toolboxes, Code generation, Deployment options.

UNIT III: MATLAB Machine Learning Tools 16 Hrs

Introduction to Machine Learning, Supervised and Unsupervised Learning Algorithms, Preprocessing and Feature Engineering, Cross Validation and Model Evaluation, Hyperparameter tuning, Ensemble learning, Deep learning integration, Time series analysis, Model deployment, Interactive Apps, GPU acceleration, Classification, Regression and clustering, Interpretability and Explainability

UNIT IV: MATLAB based ANN and ML applications 16 Hrs

Image and Pattern recognition, Speech recognition, Facial recognition, Plant diseases detection.

BOOKS FOR STUDY:

1. MATLAB Deep Learning with Machine Learning Neural Networks and Artificial Intelligence by Kim.
2. Intro to Neural Net with MATLAB 6.0 by Sivanandam S N, McGraw Hill
3. Neural Networks and Learning Machines by Simon Hykin
4. MATLAB for Machine Learning by Ciaburro Giuseppe

OUTCOME OF THE COURSE:

By the end of the course students will be able to

1. Understand the foundation of AI and Machine learning.
2. Apply problem solving strategies.
3. Apply AI and Machine Learning in real world problem solving.

Course OET 2.1(a): INTRODUCTION TO ELECTRONIC INSTRUMENTATION

(Open Elective Paper-I offered to other Department Students)

Teaching hours per week: 2 Total Hours: 32

Preamble:

This paper is offered to other department students. This paper deals with fundamentals of instrumentation with the general functional elements and brief study of transducer, signal conditioner, data presentation elements.

Unit -I Introduction to Instrumentation 16Hrs

Functional elements of measurement system. Classification of Instruments. Standards and calibration. Static characteristics of an instrument. Transducers: Definition, types, characteristics, selection. Temperature, pressure, and displacement transducers, Strain gauges.

Unit – II Signal Conditioners and Recorders 16Hrs

Signal conditioning: Amplifiers, Introduction to Operational Amplifiers. Characteristics of an Ideal and Practical operational amplifier. Op-Amp configurations, mathematical operations, Solutions of second order differential equations, Wave form generation, Instrumentation amplifier, filters. Data presentation elements: Galvanometric recorders, CRO, Magnetic tape recorders and LED/LCD display.

BOOKS FOR STUDY:

1. Instrumentation Measurement Analysis - Nakra and Choudary
2. Measurement of Systems—Application and Design — Earnest O Doeblin
3. Sensors & Transducers – Patranabis

BOOKS FOR REFERENCE:

1. Electronic Instrumentation and Measurement Techniques — W D Cooper & A D Helfriek

OUTCOME OF THE COURSE:

1. The students understand the basic elements of Instrumentation system
2. Students will have good grasp of transducers/ Signal Conditioners/ Data Presentation Elements.

Course OET 2.1(b): INSTRUMENTATION FOR PHYSICAL AND LIFE SCIENCES - I

(Open Elective Paper-II offered to other Department Students)

Teaching hours per week: 2 Total Hours: 32

Preamble:

This paper is offered to other department students. The analytical instruments play an important role in analyzing the sample both qualitatively as well as quantitatively. This paper deals with principles, instrumentation and working of various analytical instruments viz., Colorimeter, Spectrometers, Conductivity meter, pH meter and Polarograph and their applications.

UNIT I: Colorimeters and Spectrophotometers 16 Hrs

Colorimeters- Principle and working with a Block diagram. Salient features of individual blocks. Specifications of a colorimeter. Applications of colorimeters to Analytical and Biomedical purposes. Spectrophotometers-Principle and working with block diagram. Salient features of individual blocks. Specification and operation of Spectrophotometer. Types of spectrophotometers –UV-Visible, and Infrared Raman Spectrometer and atomic absorption spectrophotometer, and Atomic absorption spectrometer. Applications of Spectrophotometers for chemical analysis.

UNIT II: Conductivity, pH Meters and Polarographs 16 Hrs

Conductivity Bridge- Principle and working of a conductivity bridge with a block diagram. Salient features of individual blocks. Applications of conductivity bridges. pH meters- Principle and working with a block diagram. Salient features of individual blocks. Types of pH meters: μC based pH meter, Applications of pH meters in chemical and industrial fields. Polarograph- principle and working with a block diagram. Salient features of individual blocks. Characteristics of dropping mercury electrode. Polarogram: Computer based pulse Polarograph, Applications of polarograph in chemical and industrial fields.

BOOKS FOR STUDY:

1. Hand Book of Analytical Instruments- R. S. Khandpur
2. Instrumental methods of Analysis- Chatwal and Anand
3. Principles of Instrumental Analysis- Skoog
4. Instrumental methods of Chemical Analysis- B. K. Sharma

BOOKS FOR REFERENCE:

1. Instrumental methods of Analysis- Willard, Merrit and Dean.
2. Molecular Spectroscopy- Singh and Dikshit
3. Instrumental Analysis- Mann, Wickers and Gulick.

OUTCOME OF THE COURSE:

1. The students understand the principle and working of various analytical instruments.
2. Students will appreciate the significance of analytical instruments in physical/ Life Sciences

III – SEMESTER

Course HCT 3.1: SCIENTIFIC/ ANALYTICAL INSTRUMENTATION

Teaching hours per week: 4 Total Hours: 64

Preamble:

The analytical/scientific instruments play an important role in analyzing the sample both qualitatively as well as quantitatively. This paper deals with principles, instrumentation and working of various analytical instruments viz., Colorimeter, Spectrometers, Conductivity meter, pH meter, Polarograph, ESR, NMR, Mass, Photo acoustic, Spectrometer, Electronic microscope, thermal analyzers and Chromatographs and their applications.

UNIT I: Colorimeters and Spectrophotometers 16 Hrs

Colorimeters- Principle and working with a Block diagram. Salient features of individual blocks. Specifications of a colorimeter. Applications of colorimeters to Analytical and Biomedical purposes. Spectrophotometers-Principle and working with block diagram. Salient features of individual blocks. Specification and operation of Spectrophotometer. Types of spectrophotometers –UV-Visible, and Infrared Raman Spectrometer and atomic absorption spectrophotometer, and Atomic absorption spectrometer. Applications of Spectrophotometers for chemical analysis. Flame photometer.

UNIT II: Conductivity, pH Meters and Polarographs 16 Hrs

Conductivity Bridge- Principle and working of a conductivity bridge with a block diagram. Salient features of individual blocks. Applications of conductivity bridges. pH meters- Principle and working with a block diagram. Salient features of individual blocks. Types of pH meters: μC based pH meter, Applications of pH meters in chemical and industrial fields. Polarograph-principle and working with a block diagram. Salient features of individual blocks. Characteristics of dropping mercury electrode. Polarogram: Computer based pulse Polarograph, Applications of polarograph in chemical and industrial fields. Ion analysers, Cyclic Voltammetry. GCD Analyser.

UNIT III: Resonance and Mass Spectrometers 16 Hrs

Nuclear Magnetic Resonance Spectrometers- Principle and working with suitable schematic/block diagrams. Experimental arrangement. Salient features of individual blocks. Applications of NMR spectrometer. Electron Spin Resonance- Principle and working with suitable schematic/block diagrams. Experimental arrangement. Salient features of individual blocks. Applications of ESR spectrometer. Mass Spectrometer: Principle and working with schematic/block diagrams. Experimental arrangement. Salient features of individual blocks. Applications of Mass spectrometer. PAS: Principle and working with block diagram, experimental arrangement, Salient features of individual blocks. Application of PAS. XRD, XRF.

UNIT IV: Electron Microscopes, Thermal Analysis and Chromatographs 16 Hrs

Transmission Electron Microscope- Principle and working with a block diagram. Salient features of individual blocks. Scanning Electron Microscope- Principle and working with a block diagram. Description of individual blocks. Applications of Electron Microscopes. Thermo gravimetric and Differential Thermal Analysis-Principle and working with a Schematic diagram Description of individual blocks. Applications. Differential Scanning Calorimeter: Principle, working and Applications. Chromatographs-Gas and Liquid Chromatographs- Principle and working with a block diagram. Applications.

BOOKS FOR STUDY:

1. Hand Book of Analytical Instruments- R. S. Khandpur
2. Instrumental methods of Analysis- Chatwal and Anand
3. Principles of Instrumental Analysis- Skoog
4. Instrumental methods of Chemical Analysis- B. K. Sharma

BOOKS FOR REFERENCE:

5. Instrumental methods of Analysis- Willard, Merrit and Dean.

6. Molecular Spectroscopy- Singh and Dikshit
7. Instrumental Analysis- Mann, Wickers and Gulick.

OUTCOME OF THE COURSE:

1. After studying the paper, the students understand the principles, working and instrumentation involved in the various Scientific/ Analytical Instruments.
2. The students also understand the features of individual elements of various Scientific/Analytical instruments and Applications of Analytical instruments for sample analysis
3. Students will be able to design, analyze and fabricate various Scientific/ Analytical instruments.

Course HCT 3.2: PROCESS INSTRUMENTATION

Teaching hours per week: 4 Total Hours: 64

Preamble:

This paper deals with the study of principle/ design/ working of various instrumentation systems for the measurement of various parameters such as temperature pressure, flow, force, humidity, moisture, level, density etc.

UNIT I: Temperature and Pressure Measurement Systems 16 Hrs

Temperature measurement, International practical temperature scale, Non–electrical temperature measurement systems, Electrical temperature measurement systems and Radiation type temperature measurement systems. Moderate Pressure measurement systems, High pressure measurement systems, Low pressure or vacuum measurement systems, calibration and testing. Applications – Temperature, Pressure measurement and control system.

UNIT II: Flow, Humidity and Moisture Measurement Systems 16 Hrs

Primary or quantitative meters, secondary or Rate Meters, Special Methods – Ultrasonic flow meters, Electromagnetic flow meters, Anemometers, Laser Doppler Anemometers. Humidity: Definitions of absolute, specific and relative humidity and Dew point. Psychrometers, Hair hygrometer, Electrolysis type hygrometer, Dew point measurement. Moisture: Definition, Resistivity, Conductivity and Capacitance type, NMR and IR methods for moisture measurement. Applications - Humidity, Moisture measurement and control systems

UNIT III: Level, Density and Gases Measurement Systems 16 Hrs

Float type, Displacer type, Hydrostatic type level measurement systems, Electrical methods - Resistance and capacitance type level measurement systems, Radiation methods – Ultrasonic and Radioactive type level measurement systems. Liquid density, units and definitions - Displacement and float type Densitometers. Hydrometers – Hydrostatic, ultrasonic sludge, sonic, ball type, Capacitance – Oscillating Coriolis and Radiation Densitometers. Applications – Level, Density measurement and control systems. Gases sensors types, working principle – Semiconductor, Electro

UNIT IV: Process control elements 16 Hrs

Basic control actions – Proportional (P), Proportional + Integral (PI), Proportional + Derivative (PD), Proportional + Integral + Derivative (PID), Fuzzy Logic Controllers (FLC), hydraulic, Pneumatic and Electronic Controllers. Single loop controllers. Digital PID Controllers, Cascade and Feed Forward Control Systems, Direct Digital Control Systems, Supervisory Control Systems, Distributed Control Systems (DCS), Programable Logic Controllers (PLC).

BOOKS FOR STUDY:

1. Industrial Instrumentation and Control – S. K. Singh
2. Instrumentation Measurement Analysis–Nakra & Chaudhry
3. Instrumentation Devices and systems –Rangan, Mani & Sharma
4. Instrumentation and Control Systems – S. Bhaskar
5. Process Instrumentation – Patranabis

6. Industrial Instrumentation – T.R. Padmanabhan

BOOKS FOR REFERENCE:
1. Industrial/Process Instrumentation – Douglas M. Considine
2. Instrument Engineer's Handbook: Process Measurement and Analysis - B. G. Liptak
3. Instrument Engineer's Handbook: Process Control – B. G. Liptak

OUTCOME OF THE COURSE:
1. After studying the paper, the students will be able to design instrumentation system for the measurement and control of various industrial parameters such as Temperature, pressure, Humidity etc.…
2. Students will have the knowledge of various process control elements P, PI, PID, FLC, PLC, SCADA, DCS. etc... and their implementation in industry.

Course HCT 3.3: BIOMEDICAL ELECTRONICS

Teaching hours per week: 4 Total Hours: 64

Preamble:
This paper deals with a study of various instruments used for measuring biological parameters. Various electrodes/amplifiers/recorders of biological signals are studied. Both Diagnostic and Therapeutic Biomedical equipment are studied. Arduino based applications are dealt.

UNIT I: Introduction to Biomedical Electronics 16 Hrs
Sources of Biomedical Signals, Block diagram of Medical Instrumentation System, General constraints in design of medical instrumentation System, Bioelectric Signals and Electrodes, Biomedical Transducers, Biopotential Amplifiers

UNIT II: Biomedical Diagnostic Equipment 16 Hrs
ECG, EEG, EMG, Sphygmomanometer, Respirometer, Gas analyzers. Imaging Techniques: X-ray, image intensifier, Computer tomography, Magnetic resonance imaging, ultrasound scanner, 2D/3D echo imaging, PET scan imaging, Thermal Imaging. Applications of laser in Diagnosis.

UNIT III: Biomedical Therapeutic Biomedical Equipment 16 Hrs
Pacemaker, Defibrillator, Surgical Diathermy, Laser applications in therapy, IR applications in Physiotherapy, Hemodialysis, Lithotriptor, Anesthesia machine, Heart-lung instrument, ventilators, nebulizers, Drug delivery system, Smart Inhalers.

UNIT IV: Microcontroller/IoT based applications 16Hrs
Pulse and SPO_2 measurement system, ECG measurement system, EMG measurement system, EEG measurement system, Body Temperature measurement system, Respiration rate measurement system, GSR measurement system, Patient monitoring system. Raspberry pi based medical image processing.

BOOKS FOR STUDY:
1. Hand book of Biomedical Instrumentation -R S Khandpur
2. Biomedical Instrumentation & Measurements- Leslie, Cromwell, Fred Wailbell, Erich, Pfeiffer
3. Biomedical Instrumentation – Arumugam
4. Biomedical Equipment and Technology – Joseph Brown

BOOKS FOR REFERENCE:
1. Biomedical Instrumentation and Measurements, Allied- Harry E Thomas.
2. Hand book of Biomedical Engineering –Jacob Kline
3. Transducers for Biomedical Measurements –Richard S C Cobold
4. Biomedical Electronics- Joseph Dubovy

OUTCOME OF THE COURSE:

1. Students will be familiar with Biomedical Signals/ Transducers/ Electrodes
2. Students will appreciate the significance of both Diagnostic and Therapeutic Biomedical Equipment for the measurement of various parameters of Human Body
3. Students will be able to design IoT/ Arduino based biomedical instruments for Biomedical applications.

Course SCT 3.1(a) : IOT WITH ARDUINO, ESP, AND RASPBERRY PI

Teaching hours per week: 4 Total Hours: 64

Preamble:

This paper deals with the different IoT architectures, skills required for interfacing sensors and actuators with different IoT architectures and data collection and logging in the cloud.

Unit I – Introduction to IoT 16 Hrs

IoT- introduction and its components, IoT building blocks, Sensors, Signal Conditioners and Actuators, IoT Devices, IoT boards (Arduino Uno, ESP 8266-12E Node MCU, and Raspberry Pi 3).

Unit II - Arduino Uno 16 Hrs

Arduino Uno – getting started with the Uno boards, blink program, connection of sensors to the Uno board, reading values of sensors from the Uno board, interrupts. Case study: Humidity, Temperature, level, voltage, current, resistance, capacitance measurement and Temperature Control; Case Study: Sending values of parameters viz., Temperature, Humidity etc. to the Internet via GSM module. Interfacing Bluetooth and RF module with Arduino boards.

Unit III – ESP 8266 16 Hrs

ESP 8266-12E Node MCU – getting started with the ESP board, Micropython and Esplorer IDE, Flushing the ESP8266 board with micropython, connecting sensors to the ESP board, Connecting ESP board to WiFi, Interfacing ESP with the Cloud (REST API-GET, POST, MQTT), interrupts, comparison of ESP 32 board with the ESP 8266 board. Case Study: Switching light on /off remotely. Case Study: Voice-based Home Automation for switching lights on/off (Android phone – Google Assistant (Assistant <-> IFTTT), MQTT (ESP <-> IFTTT), ESP 8266 <-> Lights).

Unit IV – Raspberry Pi 4 16 Hrs

Raspberry Pi 4 – Rpi 4 introduction and installing the Raspbian Stretch OS, Headless - Computer and Rpi4 configuration to connect through SSH via Ethernet, Headless : connecting Rpi4 remotely without Ethernet cable via SSH, IP address, Rpi 4 - Testing the GPIO pins through Scripts. Raspberry pi4 interfacing with Sensor DHT11, Raspberry pi4 python library installation and reading sensor feed, 'Plug and play ' type cloud platform overview for integration to IOT devices, 'Plug and play' cloud platform for integration to IOT device - actuator (LED), Plug and play platform - Custom widget (DHT11-Sensor) integration through Python., Lora wan /LPWAN – Overview.

Text Books/References:

1. Rao, M. (2018). Internet of Things with Raspberry Pi 3: Leverage the power of Raspberry Pi 4 and JavaScript to build exciting IoT projects. Packt Publishing Ltd
2. Baichtal, J. (2013). Arduino for beginners: essential skills every maker needs. Pearson Education.
3. Schwartz, M. (2016). Internet of Things with ESP8266. Packt Publishing Ltd.
4. Richardson, M., & Wallace, S. (2012). Getting started with raspberry PI. " O'Reilly Publisher Media, Inc."

Course Outcomes:

1. After completion of course students understand Arduino Uno, NODE MCU 8266 and Raspberry PI along with protocols and its communication to cloud.
2. Students acquire the skills to interface analog sensors and digital sensors with IOT devices.
3. Students will have the knowledge and skills to design and fabricate IOT systems viz., Humidity, Temperature etc., measurement and control systems.

Course SCT 3.1(b) DIGITAL SIGNAL PROCESSORS AND APPLICATIONS

Teaching hours per week: 4 Total Hours: 64

Preamble:

DSP is one of the important digital devices used in instrumentation. This paper deals with the study of DSPs. Preliminary mathematical fundamentals such as Fourier series, Fourier Transform, Z-Transform are dealt. Theoretical design of digital filters such as IIR, FIR filters are described. Architecture/Programming/ Interfacing of TMS320C5X is dealt along with typical applications.

UNIT I: Introduction to Digital Signal Processing 16 Hrs

Signals, Systems & signal processing, Discrete time Signals, Systems, Types, Advantages of DSP, Fourier series and Fourier transform – Definition, theorem & properties. Z- Transform – Definition, Theorem & Properties. Inverse Z- transform- solutions of differential equations and Transfer function.

UNIT II: Digital Filter Design 16 Hrs

Analog filters v/s Digital filters. Design of IIR Filters from Analog filters, IIR filter deign by approximation of derivatives, by impulse invariance, by bilinear transformation. Design of Butterworth & Chebyshev filters. Design of FIR filters using windows.

UNIT III: Architecture and Programming of TMS320C5X Digital Signal Processor 16 Hrs

Architectural overview: Functional Block Diagram, Internal Hardware. Memory Organization: Data memory, Program memory, Interrupts, Serial ports. Addressing modes. Instruction set of TMS320C5X and Programming.

UNIT IV: Interfacing and Applications 16 Hrs

Interfacing of Codec (A/D and D/A Converters) with TMS320C5X DSP. FIR Digital Filter: Low-pass, High-pass, Band-pass and Band reject. Interfacing of DDS with DSP and generation of Sine/Cosine and other waveforms. DSP based lock-in Amplifier.

BOOKS FOR STUDY:

1. Digital Signal Processing: Principles, algorithm & applications–J G Proakis, D G. Manolakis
2. Introduction to Digital Signal Processing –Johnny R. Johnson
3. Digital Signal Processing – S. Salivahan, A. Vallaraj, C. Gnanapriya
4. Digital Filters Analysis, Design and Application – Andreas Antonio
5. DSP TMS320C5X Architecture, Programming - B. Venkataramani and M. Bhaskar

BOOKS FOR REFERENCE:

1. Digital Signal Processing – Sanjit K.Mitra
2. Digital Signal Processing and Application – Pamos E. Papamichalis.
3. TMS3205X User's Guide – Texas Instruments

OUTCOME OF THE COURSE:

1. After studying the paper, the students will be able to design IIR/FIR filters using MATLAB
2. Students will understand the role of DSP in Instrumentation and also construct the digital filters

3. Students get familiar with DSP based applications.

Course OET 3.1(a): INTRODUCTION TO MICROPROCESSORS AND MICROCOMPUTERS

(Open Elective Paper-II offered to other Department Students)

Teaching hours per week: 2 Total Hours: 32

Preamble:

This paper is opted for other department students. This paper deals with the introduction to 16-bit microprocessors and their comparative study 8086 Microprocessor architecture/ instruction set/programming/interfacing will be dealt.

UNIT I: Introduction to 16-bit Microprocessor 16 Hrs

Architecture of 8086 Microprocessor, Addressing modes, Instruction set, Assembly language programs using Assemblers, Procedures and Macros, Assembly language program development tools, Debugging assembly language programs, Comparative study with 8088, 80286, and 80486 Microprocessors.

UNIT II: Interfacing 16 Hrs

Memory and I/O organization, Memory Banks, Interfacing of Memory (RAM and EPROM), Programmable Peripherals 8255, 8254: Block diagram, programming, and Interfacing with 8086 µP. 8086 Interrupts and their responses. Interfacing of Binary Counter Display and Seven Segment Display with 8086 through 8255.

BOOKS FOR STUDY:

1. Microprocessor and Interfacing: Programming and Hardware – Douglas V. Hall

OUTCOME OF THE COURSE:

1. Students will understand the Architecture, Instruction set, Programming and Interfacing skills of 8086 Microprocessor.

Course OET 3.1(b): INSTRUMENTATION FOR PHYSICAL AND LIFE SCIENCES - II

(Open Elective Paper-II offered to other Department Students)

Teaching hours per week: 2 Total Hours: 32

Preamble:

This paper is opted for other department students. The analytical/scientific instruments play an important role in analyzing the sample both qualitatively as well as quantitatively. This paper deals with principles, instrumentation and working of various analytical instruments viz., NMR, Mass, Photo acoustic, Spectrometer, Electronic microscope, thermal analyzers and Chromatographs and their applications.

UNIT I: Resonance and Mass Spectrometers 16 Hrs

Nuclear Magnetic Resonance Spectrometers- Principle and working with suitable schematic/block diagrams. Experimental arrangement. Salient features of individual blocks. Applications of NMR spectrometer. Electron Spin Resonance- Principle and working with suitable schematic/block diagrams. Experimental arrangement. Salient features of individual blocks. Applications of ESR spectrometer. Mass Spectrometer: Principle and working with schematic/block diagrams. Experimental arrangement. Salient features of individual blocks. Applications of Mass spectrometer. PAS: Principle and working with block diagram, experimental arrangement, Salient features of individual blocks. Application of PAS.

UNIT II: Electron Microscopes, Thermal Analysis and Chromatographs 16 Hrs

Transmission Electron Microscope- Principle and working with a block diagram. Salient features of individual blocks. Scanning Electron Microscope- Principle and working with a block diagram. Description of individual blocks. Applications of Electron Microscopes. Thermo gravimetric and Differential Thermal Analysis-Principle and working with a Schematic diagram Description of individual blocks. Applications. Differential Scanning Calorimeter: Principle, working and Applications. Chromatographs-Gas and Liquid Chromatographs- Principle and working with a block diagram. Applications.

BOOKS FOR STUDY:

1. Hand Book of Analytical Instruments- R. S. Khandpur
2. Instrumental methods of Analysis- Chatwal and Anand
3. Principles of Instrumental Analysis- Skoog
4. Instrumental methods of Chemical Analysis- B. K. Sharma

BOOKS FOR REFERENCE:

1. Instrumental methods of Analysis- Willard, Merrit and Dean.
2. Molecular Spectroscopy- Singh and Dikshit
3. Instrumental Analysis- Mann, Wickers and Gulick.

OUTCOME OF THE COURSE:

1. The students understand the principles, working and instrumentation involved in various Scientific/ Analytical Instruments.
2. The students also understand features and applications of various instruments in the sample analysis.