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
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							
		Personality Development Skills	**-**	**-**	**-**	**-**	**-**	**-**	**2**
		Total for Third Semester	**520**	**130**	**650**	**18**	**0**	**08**	**28**

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.

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. Polorograph-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.

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.

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 and Density 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

UNIT IV: Process control elements

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

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

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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.