Syllabus

MSc in Instrumentation & Applied Physics

(Choice Based Credit System)

Revision Cycle 3.0, November 2019

Department of Instrumentation & USIC, Gauhati University
Web : https://gauhati.ac.in
GUWeb : http://web.gauhati.ac.in/syllabus

MSc in Instrumentation & Applied Physics (CBCS)
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November 2019

Legends : L - Lecture P - Practical C - Credits T - Tutorial

This is approved in the Academic Council held on 08.11.2019

Course Structure for MSc in Instrumentation and Applied Physics (under CBCS 2019)

Semester-I

Course	Course Title	Hrs/week	Credit				Marks		Total Marks
			L	T	P	C	Internal	Final	
IAP-1014	Instrumentation & Measurement Techniques	4	3	1	-	4	40	60	100
IAP-1024	Applied Mathematics	4	3	1	-	4	40	60	100
IAP-1034	Automatic Control System	4	3	1	-	4	40	60	100
IAP-1044	Analog and Digital Electronics	4	3	1	-	4	40	60	100
IAP-1053	*Workshop and Engineering Drawing*	6	-	-	3	3	50	-	50
IAP-1066	*Instrumentation Lab-I*	12	-	-	6	6	40	60	100
	Instrumentation Lab-I: Analog, Digital, Sensor								

Total Credits = 25 Total Marks = 550

Semester-I

Course	Course Title	Hrs/week	Credit				Marks		Total Marks
			L	T	P	C	Internal	Final	
IAP-2014	Industrial Instrumentation	4	3	1	-	4	40	60	100
IAP-2024	Numerical Method and Computer Programming	4	3	1	-	4	40	60	100
IAP-2034	Microprocessor and Microcontroller	4	3	1	-	4	40	60	100
IAP-2044	Material Science	4	3	1	-	4	40	60	100
IAP-2053	*Computer Programming (C/C++)*	6	-	-	3	3	50	-	50
IAP-2066	*Instrumentation Lab-II*	12	-	-	6	6	40	60	100
	Instrumentation Lab-II: Microprocessor Interfacing, Industrial Instrumentation and Material Science								

Total Credits = 25 Total Marks = 550

Semester-III

Course	Course Title	Hrs/week	Credit				Marks		Total Marks
			L	T	P	C	Internal	Final	
IAP-3014	Communication Techniques	4	3	1	-	4	40	60	100
IAP-3024	Process Control and Industrial Automation	4	3	1	-	4	40	60	100
IAP-3034	Digital Signal Processing	4	3	1	-	4	40	60	100
IAP-3046	Forensic Instrumentation	6	4	2	-	6	40	60	100
IAP-3056	Advanced Embedded System	6	4	2	-	6	40	60	100
IAP-3063	*Instrumentation Lab-III*	6	-	-	3	3	50	-	50
IAP-3076	*Instrumentation Lab-IV*	12	-	-	3	3	40	60	100
	Instrumentation Lab-III: Forensic Instrumentation / Advanced Embedded System *Instrumentation Lab-IV: Communication Techniques, Process Control, Industrial Automation*								

Total Credits = 27 Total Marks = 550

IAP-3046 and IAP-3056 are elective papers. Students must choose any one of the following papers.

Departmental: A. Forensic Instrumentation (IAP3046) B. Advanced Embedded System (IAP3056)
Interdepartmental (Dept. of ECT): Introduction to Nanoscience & Nanotechnology (ECT304C)

Semester-IV

Course	Course Title	Hrs/week	Credit				Marks		Total Marks
			L	T	P	C	Internal	Final	
IAP-4014	Analytical Instruments	4	3	1	-	4	40	60	100
IAP-4024	A: Entrepreneurship Skills	2	2	-	-	2	20	30	50
	B: Virtual Instrumentation and CAD for Instrumentation	2	2	-	-	2	20	30	50
IAP-4034	Optical Instruments and Photonics	4	3	1	-	4	40	60	100
IAP-4046	Biomedical Instrumentation	6	4	2	-	6	40	60	100
IAP-4056	Advanced Industrial Automation	6	4	2	-	6	40	60	100
IAP-4063	*Instrumentation Lab-V*	6	-	-	3	3	50	-	50
IAP-4076	*Project*	12	-	-	6	6	40	60	100
	Instrumentation Lab-V: Advanced Industrial Automation / Biomedical Instrumentation								

Total Credits = 27 Total Marks = 550

IAP-4046 and IAP-4056 are elective papers. Students must choose any one of the following papers.

Departmental: A. Biomedical Instrumentation (IAP4046) B. Advanced Industrial Automation (IAP4056)

Learning Objectives

- Gather knowledge on design and development of instrumentation for different applications
- Understand the application of instrumentation in different fields of science and technology like biomedical, forensic, nano-technology, process industry etc.
- Understand the application of instrumentation in different social and economic issues.
- Understand the mapping from idea-invention-implementation to product development.
- Development of skilled manpower and entrepreneur.

Program Specific Outcomes

- **PSO1:** Understand the basic concept of measurement system, electronic instrumentation design, different control systems, mathematical backgrounds of instrumentation, material science etc.
- **PSO2:** Develop basic skills on electronics, circuit design, design and development of instrumentation using microprocessor and microcontroller, smart sensor and use of different integrated circuits.
- **PSO3:** Apply different instrumentation techniques on analytical procedures, biomedical instrumentation and forensic instrumentation.
- **PSO4:** Understand the application of instrumentation and control in industry, process monitoring and automation.
- **PSO5:** Understand the techniques of computer programming and implementation of these for designing intelligent instrumentation.

Contents

Part I

Semester-I

1

IAP-1014
Instrumentation & Measurement Techniques

Total Lectures : 42 **Credits : 4 (Theory : 04)**

Course Outcomes

- CO1: Describe general characteristics of a measurement system
- CO2: Categorise and compare different sensors and transducers and illustrates its applications
- CO3: Apply the concept of data acquisition techniques and telemetry

1.1 Theory

Unit I : *Generalized performance characteristics of instruments*

Characteristics of instruments, measurements of frequency, phase, time interval, impedance, measurement of power, energy and distortion, accuracy, precision, tolerance, hysteresis, loading effect, repeatability, reproducibility, Resolution, sensitivity, linearity, drift, range, response time. Dynamic characteristics: Transfer Function, Zero order instruments, First order instruments, step and ramp response of first and second order instruments, frequency response of first and second order instruments, dead time elements.

Concept of calibration standards

Unit II : *Measurement of non-electrical quantities*

Measurement of temperature (thermodynamic scale, bimetallic method, fluid expansion method), pressure(manometer, bell type, ring type, Burdon tube), flow, force, level.

Unit III : *Passive Electrical transducer*

Resistive: Resistance Thermometers, Resistive displacement Transducers, Resistive strain Transducers, Resistive Pressure Transducers.

Inductive: Inductive thickness transducers, Inductive displacement transducers, Eddy current type Inductive transducers.

Capacitive: Capacitive thickness Transducers, Capacitive displacement Transducers

Unit IV : *Active Electrical Transducers*

Thermo electric Transducers

Piezo-electric Transducers: Force transducers, strain transducers, Torque and pressure transducers, and photoelectric transducers.

Digital Transducers: Digital displacement transducers, Digital tachometers.

Unit V : *Telemetry and Data Acquisition System*

Telemetry: Introduction and characteristics, Landline Telemetry, Radio Telemetry

Data Acquisition: Components of Analog and Digital Data Acquisition System, Types of Multiplexing Systems, Uses of Data Acquisition System, Use of recorders in Digital systems, Modern Digital Data Acquisition System.

Unit VI : *Advanced Measuring Instruments*

Data Loggers, Digital Read Out Systems, Digital Input-Output devices.

Analog CRO, Digital storage CRO, Spectrum Analyzer, Logic Analyzer.

1.2 *Suggested books*

1. Ramón Pallás-Areny, John G. Webster, Sensors and Signal Conditioning, Wiley.
2. Jon S. Wilson, Sensor Technology Handbook, Elsevier
3. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, Springer
4. Rangan, Mani, Sharma: Instrumentation devices and systems, Tata McGraw Hill
5. Nakara, Chaudhari: Instrumentation, Measurement and Analysis, Tata McGraw Hill
6. E.O. Doeblin: Measurement systems, McGraw Hill
7. A.K. Sawhney, A Course in Electrical and Electronic and Instrumentation, Dhanpat Rai and Sons
8. David A. Bell, Electronic Instrumentation and Measurements, Prentice Hall of India Private Limited
9. Albert D. Helfrick and W D Cooper, Modern Electronic Instrumentation And Measurement Techniques, PHI Learning

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IAP-1024
Applied Mathematics

Total Lectures : 42 **Credits : 4 (Theory : 04)**

Course Outcomes

- CO1: Interpret the mathematical background of Instrumentation
- CO2: Apply Laplace, Fourier and Z-transform
- CO3: Construct differential equations for control system and solve
- CO4: Generate error budget of measurement system

2.1 Theory

Unit I : *Complex Analysis*

Pole , zero concept, polar system, rules for complex differentiation and integration, residue theorem and its applications.

Unit II : *Fourier Series and Fourier Transform*

Fourier series: Determination of Fourier coefficient, Fourier series of periodic functions. **Fourier Transform:** Fourier transforms, Fourier cosine and sine transforms, Properties, aperiodic function and its fourier transform. Discrete Fourier Transform and its properties.

Unit III : *Laplace transform*

Properties of Laplace transform, Inverse Laplace transforms, Laplace transform derivatives, Convolution theorem, Solution of linear ordinary differential equations, simultaneous equations and electrical circuits, Introduction to Z-transform, properties of Z-transform, concept of transfer function(TF) in s and z domain and introduction to stability of system using characteristic equation of TF.

Unit IV : *Differential equations*

First order ordinary differential equation, Systems of linear order differential equation, Linear ordinary differential equation of higher order with constant and variable coefficients, Introduction to partial differential equations.

Unit IV : *Error analysis*

Types of error, systematic and random errors, Significant figures and round-off, Uncertainties and probable error, Random variable - Mean, variance and standard deviation - Normal distribution -sampling technique - propagation of errors - Estimates of mean and errors -Instrumental uncertainties - statistical fluctuations - Chi square test - Goodness of fit. Graphical representation of data, curve fitting.

2.2 *Suggested books*

1. H. K. Dass, Advanced Engineering Mathematics, S. Chand & Co., NewDelhi
2. Ervin Kreyszig, Advanced Engineering Mathematics, John - Wiley & Sons Ltd., New Delhi (2001).
3. George Brown Arfken, Hans-Jurgen Weber,Mathematical Methods for Physicists, Elsevier
4. B. S. Grewal,Higher Engineering Mathematics, Khanna Publishers
5. L. A. Pipes and L. R. Harvil, Applied Mathematics for Engineers and Physicists

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IAP-1034
Automatic Control System

Total Lectures : 42 Credits : 4 (Theory : 04)

Course Outcomes

- CO1: Apply different mathematical tools of control system
- CO2: Explain different control mechanisms
- CO3: State stability of control system
- CO4: Generate frequency domain analysis

3.1 Theory

Unit I : *Types of Control Systems*

Block diagram representation and reduction, signal-flow graphs. Open loop and close loop system, block diagram reduction rule, system transfer function, Introduction to test signals: - unit, ramp, triangular, sine, exponential.

Unit II : *Transient and steady state response analysis*

Transient and steady state response analysis of First and second order systems; analysis of second order system and find equation for settling time, rise time, peak amplitude, damping frequency , damping factor, Routh, Hurwitz stability criteria Root locus technique, basic properties of root loci, root contour.

Unit III : *Basic control action*

Proportional, integral and derivative action; Proportional Integral Controller, Proportional-Derivative Controller, Proportional-Integral- Derivative Controller. concept of tuning, Zieglar-Nicholas time domain and frequency domain rule for PID tuning, Cohen Coon recommendations, recent development in tuning and effect on control action, Astrom and Hugglund relay tuning method, online tuning concept, examples of online tuning methods.

Unit IV : *Frequency domain analysis of control system*

PID controller, bode analysis of PID controller for second order plant, root locus analysis of PID controller and finding optimum settings of PID controller using these analysis . Nyquist stability criterion.

Unit V : *State variable analysis*

Limitations of transfer function, State variable analysis of linear dynamic system- state transition matrix, matrix representation of state equations, state transition equation, decomposition of transfer fraction, controllability and observability of linear systems.

3.2 *Suggested books*

1. Richard C. Dorf, Robert H. Bishop, Modern Control Systems, Prentice Hal
2. Joseph J. DiStefano, Allen Stubberud, Ivan Williams, Schaum's Outline of Feedback and Control Systems, Second Edition, McGraw Hill Professional
3. Katsuhiko Ogata, Modern Control Engineering,Prentice Hall
4. Kuo C Benjamin, Automatic Control Systems, PHI Learning

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IAP-1044
Analog and Digital Electronics

Total Lectures : 42 **Credits : 4 (Theory : 04)**

Course Outcomes

- CO1: Explain basics of analog electronics (BJT, FET, MOSFET, power amplifiers)
- CO2: Describe operational amplifier and its applications
- CO3: Describe Boolean Algebra, combinational and sequential logic circuits
- CO4: Describe basic concepts of data conversion techniques

4.1 Theory

Unit I : *BJT, FET, MOSFET*

Biasing techniques, BJT h-parameters. Field Effect Transistors: The junction field effect transistor, volt ampere characteristics, MOSFET, design, analysis and application of field effect transistor and MOSFET circuits Power amplifiers: Class A, Class B, Class C, push pull principle, phase inverters, neutralizations, analysis of power amplifier circuits & gain.

Unit II : *Operational Amplifier: Characteristics and applications*

Biasing Techniques: Current Source, Current Mirror, active load. Direct coupled Amplifier, AC and DC characteristics-Basic operational amplifier applications: -multiplier, divider, differentiator, integrator, instrumentation amplifier-AC amplifier-voltage and current and current to voltage converter-sample and hold circuit-log and antilog amplifiers, comparators. Active filters-low pass, high pass, band pass, band reject filters-filter design -phase lock loop -operating principles and monolithic phase-lock loops-PLL applications.

Unit III : *Boolean algebra, Logic gates and K-Map*

Universality of NAND and NOR gates. Simplification of Boolean functions - The map method -three and four variable maps - SOP and POS simplifications. Specification of Logic Families.

Unit IV : *Combinational & Sequential Circuits*

Combinational logic design procedure: Adders - Sub tractors - parity generation and checking- BCD adder - Decoders - Demultiplexers - Encoders - Multiplexers. Flip Flop and Counters: Flip Flops - Triggering of Flip Flops - Flip Flops characteristics table - Flip Flops excitation tables- RS, JK, D and T flip flop - design of counters - Ripple counters and synchronous counter-Johnson counter. State machines. Basic concept of PLA, PAL, CPLD, FPGA.

Unit V : *Data conversion techniques*

D/A conversion, Digital Potentiometer, A/D conversion-ramp, integrating, flash, counter type.

4.2 *Suggested books*

1. Millman and Halkias: Integrated electronics, Tata McGraw-Hill
2. Horowitz and Hill: Art of electronics, Cambridge University Press
3. R. F. Coughlin and Driscoll, Op-amps and linear ICs, Prentice Hall
4. Millman and Halkias, Electronic devices and circuits, McGraw-Hill
5. Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, Prentice-Hall
6. A.P.Godse, U.A.Bakshi,Electronics Devices and Circuits, Technical Publications
7. G.J.Deboo and C. N. Burrows Integrated circuits and semiconductor devices: Theory and application
8. Albert Paul Malvino, Donald P. Leach, Digital principles and applications, McGraw-Hill
9. Moris Mano, Digital Design,Pearson Education India
10. A.P.Godse, D.A.Godse, Digital Electronics And Logic Design, Technical Publications
11. Charles Roth, Jr., Larry Kinney, Fundamentals of Logic Design, Cengage Learning

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IAP-1053
Workshop and Engineering Drawing

Total Lab sessions : 30 Credits : 3 (Lab : 03)

Course Outcomes

- CO1: Apply glass blowing, machine shop, welding and carpentry techniques in instrument design.
- CO2: Design and fabricate PCB
- CO3: Generate Engineering graphics with required standard

5.1 Topics to be covered

Unit I : *Mechanical and Glassblowing Workshop*

Bench work and Fitting, Practice in filing, sawing and making, drilling and tapping in metal- Fitting, Fabrication of simple items - Trisquare and Caliper.

Lathe Work Job setting: cutting, grinding and polishing of metal facing, straight and taper turning, Thread cutting, knurling.

Welding Preparation of joints, making of butt, lap, T-corner and edge joints by electric arc. Glass Blowing Section: Capillary Tube, Test Tube, Bulb, Bulb with Side Tube Joints, Glass Tube Bending, T-Joint.

Unit II : *CAD for PCB*

CAD for printed circuit board: PCB, EDA tools, Designing, Dimensioning, Editing, Fabrication technique.

Unit III : *CAD for Engineering Drawing*

CAD for designing shapes: Introduction to CAD, Basic drawing and editing, Geometric Shapes, Layers, Dimensioning, Templates & Design Center.

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IAP-1066
Instrumentation Lab-I

Total Lab sessions : 60 Credits : 6 (Lab : 06)

Course Outcomes

- CO1: Apply techniques of analog electronics in different applications
- CO2: Develop different combinational and sequential circuits of digital electronics and verify
- CO3: Calibrate different sensors and apply signal conditioning circuits

6.1 List of experiments

Unit I : *Analog Electronics*

1. Op-Amp applications - Adder, Subtractor, Multiplication, Division, Integration, Differentiation
2. Signal generation using operational amplifier (Square, triangular, saw tooth).
3. Multivibrator using IC 555.
4. Schmitt Trigger using IC 555
5. FET amplifier (CD and CS configuration)
6. Phase shift network and Oscillator using IC 741
7. Comparator with hysteresis using 741.

Unit II : *Digital Electronics*

1. Study the function of multiplexer and demultiplexer.
2. Study the function of decoder and encoder.
3. Full adder (using only NAND & NOR gates)
4. Digital comparator using XOR and NAND gates
5. Decade counter.

6. Digital to analog converter - R-2R method and Weighted method

Unit III : *Sensor and Instrumentation*

1. Characteristics of LVDT
2. Characteristics of LDR
3. Calibration of thermistor
4. Calibration of thermocouple
5. Calibration of RTD
6. Calibration of pressure sensor
7. Study of the characteristics of Load cell
8. Study of the characteristics of Hall effect transducer
9. Measurement of Resistance using AC Wheatstone bridge
10. Measurement of Capacitance using AC Desauty's bridge

Part II

Semester-II

7

IAP-2014
Industrial Instrumentation

Total Lectures : 42 **Credits : 4 (Theory : 04)**

Course Outcomes

- CO1: Categorise different industrial sensors and its applications
- CO2: Describe different devices and converters like power semiconductor devices., DC to DC converter, Motors and motor drivers
- CO3: Explain Programmable logic controller and its programming

7.1 Theory

Unit I : *Industrial Sensors*

Industrial Sensor for Temperature, Pressure, Level and Flow. Signal Conditioning, 4-20 mA transmitter, grounded load and floating load concept of I to V converter.

Unit II : *Power Semiconductor devices*

Power MOSFETs, IGBTs and Thyristors, UJT, Switching characteristics, specifications and performance comparison of power devices.

Unit III : *Converters*

DC-DC converters: Topologies and applications. **Cyclo converters:** Principle of operation and applications

Unit IV : *Motors and Motor Drives*

Types of Motors: DC Motors, AC Motors, InductionMotors, Single and Three Phase Motors, Synchronous Motors, Stepper Motors, Servo Motors. Motor Driving circuits.

Unit V : *Programmable Logic Controllers*

Programmable Logic Controllers: Ladder diagrams, Programmable Logic Controller overview, functions, features, applications, comparison with other controllers and selection process. **PLC hardware:** modules of PLC, memory, Coils, contacts, timers and counters **PLC programming:** configuration, ladder logic, function block diagram, structured text, sequential function chart, Instruction set: bit logic, compare, timer, counter, math, move, logical operations, conversion.

7.2 *Suggested books*

1. D. P. Eckman, Industrial Instrumentation, CBS Publishers & Distributors
2. W. Bolton, Industrial Control and Instrumentation, Universities Press
3. Patranabis, Principles of Industrial Instrumentation, Tata McGraw-Hill Education
4. Jones, Instrumentation measurement and feedback, Tata McGraw-Hill Education
5. Samuel Y. Liao, Microwave devices and Circuits, PHP
6. M. H. Roshid, Power Electronics: Circuits devices and applications

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IAP-2024
Numerical Methods and Computer Programming

Total Lectures : 42 **Credits : 4 (Theory : 04)**

Course Outcomes

- CO1: Illustrate the algebraic and transcendental equations
- CO2: Describe different interpolation methods
- CO3: Explain Numerical differentiation and integration and solutions of ordinary differential equations

8.1 Theory

Unit I : *Numerical solution of algebraic and transcendental equations*

The iteration method - The method of false position - Newton - Raphson method - Convergence and rate of convergence - C program for finding roots using these techniques.

Unit II : *Interpolation*

Linear interpolation - Lagrange interpolation Gregory - Newton forward and backward interpolation formula - Central difference interpolation formula - Gauss forward and backward interpolation formula - Divided differences - Properties - Newton's interpolation formula for unequal intervals - C programming for Lagrange-s interpolation.

Unit III : *Numerical differentiation and integration*

Newton's forward and backward difference formula to compute derivatives - Numerical integration: Simpson's rule - C program to evaluate integrals using Simpson's and trapezoidal rules.

Unit IV : *Numerical Solutions of ordinary differential equations*

Runge-Kutta method for solving first order differential equations - C program for solving ordinary differential equations using RK method.

Unit V : *Soft Computing*

Introduction to Soft Computing Techniques and applications.

8.2 *Suggested books*

1. S.S. Sastry, Introductory Methods of Numerical analysis, Prentice Hall of India, New Delhi (2003) 3rd Edition.
2. W.H. Press, B.P.Flannery, S.A.Teukolsky, W.T.Vetterling, Numerical Recipes in C, Cambridge University (1996).
3. Veerarajan, S.Chand, Numerical Methods in C and C++, New Delhi (2006).
4. Arne Thesen, Computer methods in operations research, Academic Press
5. H. K. Dass, Advanced Engineering Mathematics, S. Chand & Co., New Delhi

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IAP-2034
Microprocessor and Microcontroller

Total Lectures : 42 Credits : 4 (Theory : 04)

Course Outcomes

- CO1: Explain architecture of 8085, 8086 microprocessor and 8051 microcontroller
- CO2: Describe assembly language program for all of these
- CO3: Illustrate programming using C for 8051
- CO4: Describe interfacing of different peripherals with all of these

9.1 Theory

Unit I : *8085 Microprocessor architecture*

Architecture of 8085, Concept of Addressing, 8085 Registers, Introduction to 8085 Instruction Set.

Unit II : *Interfacing memory and Peripherals*

Interfacing memory and devices, I/O and Memory mapped I/O, Programmable Peripheral Interface (8255A), 8253 Timer Interface, Programmable Interrupt controller (8259), Programmable communication Interface (8251).

Unit III : *8086 Microprocessor*

Pin description of 8086- minimum and maximum mode signals - internal Architecture - register organization- General purpose, index, pointer, segment registers and flags- Bus structure - effective and Physical address and pipeline addressing modes.

Unit IV : *8086 Instructions*

8086-instruction set-instructions- data transfer - arithmetic, logical, branching and string manipulation instructions- Assembler and Assemble directives- Simple programs - addition, subtraction, multiplication and division- data transfer using string instructions.

Unit V : *8051 Microcontroller*

Microcontrollers-8051: architecture, microcontroller hardware-program and data memory-External memory- counters-timers- serial data I/O- interrupts.

Addressing modes- Instructions - data transfer instructions- logical- arithmetic jumpand call instructions- bit manipulation -Addition- sum of N numbers, Multibyte addition- subtraction-multiplication-division-biggest and smallest numbers.

Programming using 8051 C.

9.2 *Suggested books*

1. Gaonkar, Microprocessor Architecture, Programming, and Applications with the 8085, PRI
2. Douglas V. Hall, Microprocessor and interfacing, McGraw Hill
3. The 8051 Microcontroller and Embedded systems: M. A. Mazidi, J.G. Mazidi, R.D. McKinlay, Prentice Hall, 2nd Edition.
4. Programming and Customizing the 8051 Microcontroller, Myke Predko, McGraw Hill.C and 8051, Schultz Thomas W.
5. 8051 Microcontroller: Architecture, Programming & Applications, K. J. Ayala.
6. 8051 Microcontrollers an Applications-Based Introduction: David Calcutt Fred Cowan Parchizadeh; Elsevier.

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IAP-2044
Material Science

Total Lectures : 42 **Credits : 4 (Theory : 04)**

Course Outcomes

- CO1: Describe crystal structure and defects, crystal growth and nucleation
- CO2: Elaborate the mechanical and electrical properties of materials
- CO3: Describe nonlinear optical materials

10.1 Theory

Unit I : *Crystal Structure and Defects*

Bonding of solids - crystal structure- NaCl, CsCl and ZnS-Reciprocal lattice- Method of Determining crystal structure - X ray Diffraction - Electron Diffraction - Neutron Diffraction - Structure Determination - Imperfection in crystals - Point defects - Line imperfection - Burger vector.

Unit II : *Crystal Growth and Nucleation*

Nucleation and thermodynamics of crystal growth - Theories of crystal growth - Volume theory - Kossel Theory - Bravais theory - BCF theory - Low temperature solution growth - Evaporation method -Gel method - Melt method - Bridgmann method - Czochralski crystal pulling technique - Chemical Vapour transport method.

Unit III : *Mechanical Properties*

Strength: Elasticity - Plasticity- Ductility - Malleability- Toughness- Hardness - Testing of Materials - Non-destructive Tests - Radiographic - Photo elastic and Ultrasonic methods of testing - Methods of Hardness Testing - Mechanism of deformation - Griffth's theory of fracture. (b) Alloys: Ceramics and glasses - cement and concrete-organic polymers composite materials.

Unit IV : *Electrical Properties of Materials*

Properties of Metals - Free electron Gas- Free electron theory - Zone theory of solids - Classification of conductors, insulators and semiconductors based on Zone theory - one dimensional Brillouine Zones - construction - Variation of electrical conductivity with temperature-Fermi level - carrier concentration of Intrinsic semiconductor - Barrier potential across PN Junction - Junction properties rectifier equation - Hall effect, Hall mobility, Experimental Determination of Hall coefficient, Dielectrics - Types of Polarizability - Clausius-Mosotti relation.

Unit IV : *Nonlinear optical materials*

Wave propagation in an anisotropic crystal - Polarization response of materials to light - Harmonic generation - Second harmonic generation - Sum and difference frequency generation - Phase matching - Borates - Urea, Thiourea complex.

10.2 *Suggested books*

1. S.M. Sze, Semiconductor Devices - Physics and Technology , Wiley
2. Neamen, Semiconductor Physics And Devices, Tata McGraw-Hill Education
3. Kittel, Introduction to solid state physics, Wiley
4. Ben G Streetman , Sanjay Kumar Banerjee, Solid State Electronic Devices, PHI Learning
5. Dekker, Solid State Physics, Macmillan India
6. G.J.Deboo and C. N. Burrows Integrated circuits and semiconductor devices: Theory and application

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IAP-2053
Computer Programming (C/C++/MATLAB)

Total Lab sessions : 30 Credits : 3 (Lab : 03)

Course Outcomes

- CO1: Explain basics of C programming
- CO2: Implement C program on numerical techniques

Unit I : *C program on the following numerical techniques*

1. Newton - Raphson method. Finding roots of equation
2. Gauss elimination method
3. Lagnangians interpolation method
4. Trapezoidal rule
5. Simpson rule
6. Eulers method
7. Range Kutta method (fourth order)
8. Finite difference method
9. Curve fitting (Least square)
10. Mean, mode and standard deviation
11. Chi square test

12

IAP-2066
Instrumentation Lab-II

Total Lab sessions : 60 Credits : 6 (Lab : 06)

Course Outcomes

- CO1: Compile and verify programs for Microprocessor and microcontroller
- CO2: Integrate peripherals with microprocessor
- CO3: Apply circuits like instrumentation amplifier, I-V, V-I, F-V converters, Active filters etc. for different experiments on industrial instrumentation
- CO4: Compile and verify PLC program

12.1 List of experiments

Unit I : *Microprocessor and Interfacing*

1. Simple programs: addition, subtraction, multiplication and division
2. Find the smallest and biggest numbers in a given array
3. Find the ascending and descending order in a given array
4. Block of data transfer using string instructions
5. Find the character in a string
6. Traffic light controller
7. Relay control
8. Logic controller

Unit II : *Industrial Instrumentation and Material Science*

1. Construct Instrumentation amplifier using operational amplifier
2. Signal conditioning Circuit using operational amplifier
   (a) Current to Voltage Converter

   (b) Voltage to Current converter
   (c) Voltage to frequency converter
   (d) Frequency to voltage converter
3. Active filters using operational amplifier
4. PLC Programming
5. Characteristics of photo transistor or photodiode
6. Characteristics of different LED's
7. Hall Effect
8. Band Gap

Part III

Semester-III

13

IAP-3014
Communication Techniques

Total Lectures : 42 **Credits : 4**

Course Outcomes

- CO1: Describe basic analog and Digital communication system
- CO2: Describe optical fibre communication
- CO3: Describe Transmission Lines
- CO4: Explain Microwave communication
- CO5: Describe EM Wave propagation using Antenna

13.1 Theory

Unit I : *Communication Systems*

Concept of electronic communication, AM and FM its detail mathematical analysis, Fourier analysis of AM and FM spectrum, analog circuits for modulation and demodulation. Analog IC's for modulation and demodulation.

Pulse modulation: PAM,PPM,PDM, PCM.

Digital carrier systems: BPSK, ASK, FSK, PSK, DPSK. Concept of a TDM and FDM.

Unit II : *Optic fiber Communication*

Fiber optics-Different types of fiber: Step index and Graded index and single mode optical fibers- signal degradation fibers: Absorption, attenuation, Scattering losses and dispersion-Optical sources and detectors (quantitative Only)-Power launching and coupling: Source to fiber launching -fiber joints- Splicing techniques- general optical communication system.

Basic blocks of fiber optic communications: Transcievers, signal transmitting medium, repeaters. Active and passive components in fiber optic communication system.

Basic idea on Time division multiplexing (TDM), Wavelength division multiplexing (WDM) and dense wavelength division multiplexing (DWDM) system.

Unit III : *Transmission Lines*

Equations of Voltage and Current on TX line, Propagation constant, Characteristic impedance and reflection coefficient, Impedance Transformation, Types of transmission line, Loss-less and Low-loss Transmission line and VSWR, Power transfer on TX line, Smith Chart, Admittance Smith Chart, Applications of transmission lines, Impedance Matching, Lossy Transmission Line.

Unit IV : *Microwave Communication*

Generation of microwaves, Klystron, Reflex Klystron-Multicavity Klystron, Magnetron-detection of microwaves-IMPATT, TRAPATT and Gunn diodes. Radar-radar equation-Pulse and CW radar. MTI and automatic tracking radar.

Satellite links, spherical co-ordinate system for localization of satellite, orbits and inclination- satellite construction. Satellite communication frequencies-Different domestic satellites-Intelsat system- MARISAT satellites-telemetry-Cellular concept- Multiple Access Cellular Systems- Cellular system Operation and Planning-General Principles-analog cellular systems- Digital Cellular mobile Systems- GSM- CDMA- Cellular standards.

Unit V : *Waveguides and Antenna*

Waveguides: Parallel plane waveguide, Wave propagation in parallel plane waveguide, Analysis of waveguide general approach, Rectangular waveguide, Modal propagation in rectangular waveguide, Surface currents on the waveguide walls, Field visualization and Attenuation in waveguide.

Antennas: Physical concept of radiation, Radiation pattern, Radiation Parameters of antenna, Near- and far-field regions, Reciprocity, Directivity and gain, Effective aperture, Polarization, Input impedance, Efficiency, Friis transmission equation, Radiation integrals and auxiliary potential functions, Solution for potential function, Radiation from the Hertz dipole, Power radiated by hertz dipole, Thin linear antenna, Receiving antenna, Monopole and Dipole antenna, Fourier transform relation between current and radiation pattern, Antenna arrays.

13.2 *Suggested books*

1. Dennis Roddy and John Coolen, Electonic communication, PHI private Ltd
2. G. Kennedy and Davis, Electronic communication system, TMH, New Delhi
3. Simon Haykin, Communication Systems, Wiley
4. Sanjay Sharma, Communication Systems: Analog and Digital, S.K. Kataria & Sons
5. Herbert Taub, Donald Schilling, Principles of Communication Systems, Tata Mcgraw Hill
6. G.J.Deboo and C. N. Burrows, Integrated circuits and semiconductor devices: Theory and application
7. Gerd Keiser, Optical Fiber Communication, McGraw Hill Education
8. John Kraus, Antennas and Wave Propagation, McGraw Hill Education
9. Constantine A. Balanis, Antenna Theory: Analysis and Design, Wiley
10. David M. Pozar, Microwave Engineering, Wiley
11. Charles Bostian, Satellite Communications, Wiley

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IAP-3024
Process Control and Industrial Automation

Total Lectures : 42 **Credits : 4 (Theory : 04)**

Course Outcomes

- CO1: Categorise and compare different process models
- CO2: State and explain different control modes
- CO3: Describe PLC and SCADA

14.1 Theory

Unit I : *Process Models*

Static model dynamic models, Step response methods- two parameter model, three parameter model & four parameter model. Models for oscillatory system, method of moments. Disturbance models- measuring noise characteristics.

Controller Principles: Process Characteristics - process equation, process load, process lag, self regulation Control system parameters- Error, variable range, control parameter range, control lag, dead time, cycling

Unit II : *Tuning of Controllers*

Control modes: Discontinuous- two position, multi position, floating contro Continuos - proportional, integral, derivative & composite modes Control paradigms- Cascade control, Criteria for controller tuning-specified decay ratio, minimum integral of absolute error (IAE), minimum integral of time & absolute error. (ITAE) closed loop response methods: ultimate method damped oscillation method Process reaction curve & open loop tuning.

Unit III : *Programmable Controllers and SCADA*

PLC Basics: Programmable Controllers - functional diagram, operation, programming.

PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

PLC Programming: Input instructions, outputs, operational procedures. Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

PLC Registers: Characteristics of Registers, module addressing, holding registers, input registers, output registers.

PLC Functions: Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

SCADA: Supervisory control and Data Acquisition systems implementation considerations, energy control centers, software requirements for implementing the above functions.

14.2 *Suggested books*

1. C.D Johnson, Process Control Instrumentation Technology, PHI
2. B. Wayne Bequette, Process Control: Modeling, Design, and Simulation, Prentice Hall Professional
3. Harriot, Process control, THM
4. Patranabis, Principles of process control, TMH
5. Elvin Pérez Adrover, Introduction to PLCs: A beginner's guide to Programmable Logic Controllers
6. William Bolton, Programmable Logic Controllers
7. Industrial Automation : By Mrs. S.S.Agashe. Technova Publishing House, Pune.
8. Programmable Logic Controllers - Principle and Applications by John W. Webb and Ronald A. Reiss, Fifth Edition, PHI
9. Programmable Logic Controllers - Programming Method and Applications by JR.
10. Hackworth and F.D Hackworth Jr. - Pearson, 2004.
11. Power Electronics Essentials and Applications, L. Umanand, Wiley.

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IAP-3034
Digital Signal Processing

Total Lectures : 42 **Credits : 4 (Theory : 04)**

Course Outcomes

- CO1: Categorise discrete time signals and systems
- CO2: Illustrate mathematical basics of DSP
- CO3: Describe digital filters and frequency analysis of Discrete time signals
- CO4: Describe digital signal processors

15.1 Theory

Unit I : *Discrete Time Signals and Systems*

Basic Concepts of DSP, Applications, Limitations.

Signal sampling: types of signal, sampling , Nyquist Criterion, aliasing, signal reconstruction, Qualtization, effect of finite word length.

Classification of Discrete signals and sequences: Energy and power signals, periodic and aperiodic signals, symmetric and anti-symmetric signals.

Operation on signals: shifting, time reversal, time scaling, multiplication , addition. Discrete time system and Classification: Linear Time invariant, Causal and Non causal, static and dynamic, linear and non linear.

Difference equation, impulse response and convolution, FIR and IIR system, stability

Unit II : *Z-transform*

Definition, properties of Z-transform, inverse Z-transform, system function of discrete time system, Region of Convergence, stability of discrete time system.

Unit III : *Digital Filter*

IIR Filter Design: Analog Butterworth and Chebyshev filter, frequency transformation in analog domain, Design of Digital filters using Impluse Invariance and Bilinear transformation, pre wraping, realization using Direct, Parallel and Cascade forms.

Finite Impulse response digital filters: Symmeteric and asymmetric FIR filters, Linear phase FIR filters, use of windows, frequency sampling realization of FIR filters.

Magnitude and Phase Response of Digital Filters

Unit IV : *Frequency analysis of Discrete time Systems*

Fourier series, Fourier transform, Discrete Fourier Transform, Fast Fourier transform: decimation of time and frequency.

Amplitude spectrum and power spectrum, concepts of window function.

Unit V : *Digital Signal Processors*

Need of special DSP processors, design requirements, circular buffering, fixed and floating points, Architecture of DSP.

15.2 *Suggested books*

1. John G. Proakis and Dimitris G. Manolakis, Digital Signal Processing, Principle, Algorithms and Application, 4th ed. Pearson
2. S Salivahanan, A Vallavraj and C Ganaapriya, Digital Signal Processing, Tata Macgraw Hill
3. Sanjit K Mitro, Digital signal Processing: A Computer-based Approach, McGraw-Hill
4. Digital Signal Processing: Fundamentals and application: Li Tan, Jean Jiang.
5. Digital Signal Processing, A Computer based approach, S.K Mitra

IAP-30X6

IAP30x6 is an elective paper. Students must choose any one of the following papers.

Departmental

- Forensic Instrumentation (IAP3046)
- Advanced Embedded System (IAP3056)

Interdepartmental

Dept. of Electronics and Communication Technology

- Introduction to Nanoscience & Nanotechnology (ECT304C)

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IAP-3046
Forensic Instrumentation

Total Lectures : 42 Credits : 6 (Theory : 06)

Course Outcomes

- CO1: Explain the fundamentals of forensic science
- CO2: Describe analytical techniques used in forensic Science
- CO3: Describe the fundamentals of cyber-crime investigation

16.1 Theory

Unit I : *Introduction to forensic investigation*

Crime scene and scientific evidence, trace evidences and their importance. Main branches of forensic science. Instrumental methods applied in the various branches.

Unit II : *Microscopy in forensic science*

Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM).

Unit III : *Spectroscopic techniques*

EM spectrum and its important components used in analytical methods. Interaction of radiation with matter and its consequences. Radiation detection methods.

Ultra violet and visible spectrophotometry. Atomic Absorption Spectrometry (AAS).

Atomic Emission Spectrometry (AES). Mass spectrometry.

Unit IV : *X-Ray diffraction*

X-Ray diffraction and XRF. Thermal Analysis Methods: Basic principles and theory, differential scanning colorimetry and differential analysis, thermogravimetry.

Unit V : *Cyber Crime Investigation*

Techniques for cyber crime investigation.

16.2 *Suggested books*

1. Barbara H. Stuart, Forensic Analytical Techniques, AnTs
2. J. Throck Watson and O. David Sparkman, Introduction to Mass Spectrometry: Instrumentation, Applications, and Strategies for Data Interpretation, Wiley
3. Agnieszka Kraj and Dominic M. Desiderio, Mass Spectrometry: Instrumentation, Interpretation and Applications, Wiley

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IAP-3056
Advanced Embedded System

Total Lectures : 42 **Credits : 6 (Theory : 06)**

Course Outcomes

- CO1: Illustrate architecture, programming and interfacing using PIC and ARM
- CO2: Explain Real time operating system
- CO3: Describe Reconfigurable embedded system design

17.1 Theory

Unit I : *Microcontrollers (PIC and ARM)*

Architecture - memory organization - addressing modes - instruction set - progrmming in Assembly & C - I/O port, Data Conversion, RAM & ROM Allocation, Timer programming, interrupt programming.

Unit II : *Peripherals of Microcontroller*

UART, SPI, I2C, A/D converter, CCP modules, CAN.

Unit III : *System Design*

Interfacing LCD Display ? Keypad Interfacing - Motor Control ? Controlling DC/ AC appliances ? Measurement of frequency ? Standalone Data Acquisition System

Unit IV : *RTOS Based Embedded System Design*

Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling.

Task Communication: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers. .

Unit V : *Reconfigurable Embedded System Design*

FPGA: Types of Programming Technologies, Logic Blocks (MUX, LUT), Clock Trees and managers, HARD IP, Soft IP and Firm IP, FPGA vs ASIC Design Styles.

HDL: VHDL Design flow, EDA tools, VHDL units, Data types, Operator and attributes, Concurrent and Sequential Code, Signals and Variables, State Machines.

Circuit Design: MUX, Counter, Signed and Unsigned Comparators, Parallel to Serial Converter, Seven Segment Display controller, Memory Design (RAM, ROM)

17.2 *Suggested books*

1. M. A. Mazidi, R.D., McKinlay, Causey .D, PIC Microcontroller and Embedded systems, Prentice Hall
2. M. A. Mazidi, Sarmad Naimi, Sepehr Naimi, AVR Microcontroller and Embedded systems, Prentice Hall
3. Herman Bruyninckx, Real time and embedded guide,
4. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM system developers guide designing and optimizing system software
5. Steve Ferber, ARM system on chip architecture
6. Clive Maxfield, The Design Warrior's Guide to FPGAs: Devices, Tools, and Flows
7. Smith, D. J., HDL Chip Design, Doone Publications.
8. K.C. Chang, Digital Systems Design With VHDL and Synthesis: An Integrated Approach, Wiley-IEEE Computer Society Press, First edition 1999
9. RC Cofer, Benjamin F. Harding,Rapid System Prototyping with FPGAs: Accelerating the Design Process
10. Volnei A. Pedroni, Circuit Design with VHDL Bhasker J., VHDL Primer

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IAP-3063
Instrumentation Lab-III

Total Lab sessions : 30 Credits : 3 (Lab : 03)

Course Outcomes

- CO1: Apply different techniques of instrumentation for forensic application.
- CO1: Apply Microcontrollers or Digital Signal Processors for different processes

18.1 List of experiments

Unit I : *Forensic Instrumentation*

1. Set up density gradient tubes and analyze different soil samples for forensic comparison of soil.
2. Compare glass fragments collected from crime scene on the basis of their refractive index by Becke line method.
3. Study the use of comparison microscope in forensic ballistics and compare bullet and cartridge case marks on the basis of their individual characteristics.
4. Use of SEM and XRD in Forensic applications.

Unit II : *Advanced Embedded System*

1. Write an C program for 8051 to blink an LED connected to a pin with a delay.
2. Write an C program for 8051 to turn an LED ON/OFF connected to a pin by checking the status of switch connected to another pin.
3. Write an C program for 8051 to transfer and receive data serially at a specified baud.
4. Write an C program for 8051 to read from an ADC channel and send the data serially at 9600 baud.
5. Write an ARM assembly program for MCB 2140 evaluation board to blink an LED with a delay.
6. Write an ARM thumb program for MCB 2140 evaluation board to blink an LED with a delay.
7. Implement VHDL programs for counter, adder and multiplexer on the Zedboard / Spartan 3 / SmartFusion 2 using the onboard LEDs.

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IAP-3076
Instrumentation Lab-IV

Total Lab sessions : 60 Credits : 6 (Lab : 06)

Course Outcomes

- CO1: Interpret components of communication system
- CO2: Design and customise communication system
- CO3: Interpret the components of process control and industrial automation
- CO4: Design and customise process control system for industrial use

19.1 List of experiments

Unit I : *Communication Techniques*

1. Amplitude Modulation (AM) & Demodulation.
2. Frequency Modulation (AM) & Demodulation.
3. Frequency Shift Keying (FSK) Modulation & Demodulation.
4. Pulse Width Modulation (PWM) & Demodulation.
5. Pulse Position Modulation (PPM) & Demodulation.
6. Interface a GSM module with a microcontroller and demonstrate it.

Unit II : *Process Control, Industrial Automation*

1. Measure the water level using air-bubble method and calibrate it
2. Calibrate the turbine flow sensors used in the process control board.
3. Study the characteristics of an ON-OFF controller with error band at different set points.
4. Study the characteristics of a Proportional, Integral and Differential controller at different set points.
5. Study the characteristics of composite controllers PI, PD, PID at different set points
6. Characterize the V to I and I to P converter used in the process control board.

7. Measure the controller parameters using control loop tuning methods.
8. Characterize the control valve used in the process control board

Part IV

Semester-IV

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IAP-4014
Analytical Instruments

Total Lectures : 42 Credits : 4 (Theory : 04)

Course Outcomes

- CO1: Classify and Identify different instrumental methods
- CO2: Categorise and provide techniques of NMR, ESR and Emission Spectroscopy, Mass and Atomic absorption spectroscopy
- CO3: Describe thermal methods and chromatography
- CO4: Illustrate electromechanical instruments

20.1 Theory

Unit I : *X-Ray, UV, IR and Raman Spectroscopy*

Classification of instrumental methods - introduction to spectroscopy - properties of EMR - EM Spectrum - X-ray - Instrumentation for X-ray spectrometry- X-raydiffractometer- X-ray absorption- UV spectroscopy- Origin and theory- Instrumentation - applications- Theory of IR - Instrumentation -Applications- Raman spectroscopy- Mechanism for Raman effect- Instrumentation -Applications.

Unit II : *NMR, ESR and Emission Spectroscopy*

Introduction to NMR - Quantum description of NMR - Instrumentation -Chemical shift - spin - spin coupling - applications- Theory of ESR -Instrumentation - Hyperfine splitting - determination of ?g? value - line width -theory of emission spectroscopy - instrumentation- applications.

Unit III : *Mass and Atomic Absorption Spectroscopy*

Theory of mass spectrometer - components of mass spectrometer -applications-Principles of atomic Absorption Spectroscopy - Instrumentation - Single and Double beam Atomic Absorption Spectrometers

Unit IV : *Thermal methods and Chromatography*

Introduction to thermal methods analysis - thermo gravimeter - differential thermal analysis- Chromatography- Basic parts of chromatography- Methods of measurement - Liquid chromatography - Types- amino acid analyzer- Gas Chromatography.

Unit V : *Electromechanical Instruments*

Electrochemical cell- Types of Electrodes- Conductivity meter - Polorography- Coulometers- Amperometers- Aqua meter- PH measurement- Principle- PH meters - Selective ion electrodes.

20.2 *Suggested books*

1. R S Khandpur, Handbook of Analytical Instruments, McGraw-Hill Education
2. Patranabis, Principles of Instrumentation, TMH
3. Galen W. Ewing: Instrumental methods of Chemical Analysis, McGraw Hill International
4. Willard, Merritt, Dean, Settle: Instrumental methods of Analysis, CBS Publisher
5. Skoog, Holler, Nieman: Principles of Instrumental Analysis

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IAP-4024
Entrepreneurship Skills and Virtual Instrumentation & CAD for Instrumentation

Total Lectures : 42 **Credits : 4 (Theory : 04)**

Course Outcomes

- CO1: Explain the importance of entrepreneurship for physicist and engineers
- CO2: Describe Intellectual property and its related issues
- CO3: Describe ideas on invention and product development
- CO4: Illustrate the architecture and programming techniques in Virtual Instrumentation platform

21.1 Theory

IAP-4024A: Entrepreneurship Skills

Physicists and engineers as entrepreneurs, The world of business.

Intellectual property (IP), IP generation and recording, the basics of patenting, IP management and global IP protection (USPTO, WIPO, EPO, JPO).

From invention to product: The timeline and processes, Business-plan fundamentals, the financial aspects of running a small business, marketing, pre-business feasibility analysis and opportunity assessment.

Soft Skills.

IAP-4024B: Virtual Instrumentation and CAD for Instrumentation

Block diagram, Architecture of a Virtual Instrument, Data Flow Techniques and Comparison with conventional programming.

VI programming techniques: VIs and sub-VIs, loops ,charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O.

Data acquisition basics: Introduction to data acquisition on PC, Sampling fundamentals, Input/output techniques and buses.

Common instrument interfaces: RS 232C/ RS485, GPIB.

Auto LISP: Basic arithmetic functions, advanced mathematical functions, various get functions, decision making, looping functions, handling system variables, file handling.

21.2 *Suggested books*

1. Essick, Hands on Lab View for Scientists and Engineers, Oxford University Press
2. Taqi Mohiuddin , Matthew R. Nawrocki , Rick Bitter, Labview Advanced Programming Techniques, Book World Enterprises
3. Jovitha Jerome, Virtual Instrumentation Using Labview, PHI Learning Private Limited

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IAP-4034
Optical Instruments and Photonics

Total Lectures : 42 Credits : 4 (Theory : 04)

Course Outcomes

- CO1: Describe fundamentals of optical system, Optical photoelectric System
- CO2: Illustrate LASER and its uses
- CO3: Categorise and compare different optical sensing techniques
- CO4: Describe fiber optic sensors

22.1 Theory

Unit I : *Confining Ray bundle in Optical System*

Aperture, field of view, entrance / exit window effects of Aperture, Energy flow in optical instrumentation: Light flux, Radiometry and Photometry, Radiative transfer in optical system, heterodyne and phase shifting interferometry, infrared thermometers, Types of Optical filters, specifications.

Unit II : *Optical Photoelectric System*

Types of optical detectors, characteristics, effect of spectral characteristics, Optical materials for UV, visible and IR regions.

Unit III : *Introduction to Optical Systems in LASER*

Properties of Laser, Basics of Laser Principles: active medium, laser pumping, optical feedback, laser output: line shape broadening, laser modes: optical resonance, pump rate, power output.

Unit IV : *Laser Exposition*

Working principle and construction of Gas lasers, Solid-state lasers, Semiconductor lasers, and Dye lasers, Applications of lasers.

Unit V : *Optical sensing techniques*

Optical sensing techniques and their advantages over the electronic counterparts.

Unit VI : *Fiber Optic sensors*

Different schemes for fiber optic sensing - intensity modulation, wavelength modulation, phase modulation etc. Sensing of temperature, image, displacement, pressure, flow, refractive index, relative humidity and liquid level using optical based sensors.

22.2 *Suggested books*

1. Jenkins and White, Fundamentals of Optics, McGraw Hill Education (India)
2. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, PHI Learning
3. Ghatak and Thyagarajan, Optical Electronics, Cambridge
4. Robert G Hunsperger, Integrated Optics: Theory and Technology, Springer-verlag
5. J. Wilson and J. F. B. Hawkes,Optoelectronics: an Introduction, PHI
6. Kenneth A. Jones, Introduction to optical electronics

IAP-40X6

IAP40x6 is an elective paper. Students must choose any one of the following papers.

Departmental

- Biomedical Instrumentation (IAP4046)
- Advanced Industrial Automation (IAP4056)

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IAP-4046
Biomedical Instrumentation

Total Lectures : 42 Credits : 6 (Theory : 06)

Course Outcomes

- CO1: Describe Bioelectric signals, electrodes, measurement and analysis techniques
- CO2: Explain Cardiovascular system and related issues
- CO3: Describe recording systems and Biotelemetry
- CO4: Elaborate magnetic resonance and ultrasonic imaging systems

23.1 Theory

Unit I : *Bio electric signals and Electrodes*

Fundamentals of medical instrumentation- physiological system of the body sources of biomedical signals- basic medical instrumentation- intelligent medical instrumentation system- Origin of Bio electric signals- Recording Electrodes -Silver - Silver chloride electrodes-Electrodes for ECG-Electrodes for EEG Electrodes for EMG Electrical conductivity of Electrode Jellies and Creams-Micro electrodes.

Unit II : *Recording systems and recorders*

Basic recording system-General considerations for signal conditioners preamplifiers - source of noise in low level measurements - Biomedical signal analysis technique - main amplifier and driver stage - writing systems - direct writing recorders-the ink jet recorders - potentiometric recorder-digital recorders - Instrumentation tape recorders - Electrocardiograph, Vector cardiograph, Phonocardiograph - Electroencephalograph - Electromyograph and other Biomedical recorders - Bio feedback instrumentation.

Unit III : *Measurement and analysis techniques*

The Heart and cardiovascular system - Heart Blood pressure - Characteristics of Blood flow - Heard Sounds (the cardiovascular system) - Electro cardiograph measurement of Blood pressure - measurement of Blood flow and cardiac output, Plethysmography - measurement of heat sounds - The physiology of the respiratory system of

tests and instrumentation for the mechanics - breathing-Respiratory therapy Equipment - Origin of EEG - Action Potentials of the brain evoked potentials - Anatomy of the brain- brain waves - placement of electrodes-Recording set up - Analysis of EEG.

Unit IV : *Magnetic Resonance and Ultrasonic Imaging systems*

Principles of NMR Imaging system - Image reconstruction Techniques - Basic NMR components - Biological efforts of NMR Imaging - Advantages of NMR Imaging System -Diagnostic ultra sound- physics of ultrasonic waves-medical ultra sound - basic pulse - echo apparatus, A - scan - Echocardiograph (M mode)- B-scanner - Real time ultrasonic Imaging systems - Multi element Linear Array Scanners- Digital Scan converter - Biological effects of Ultra sound.

Unit V : *Advanced Bio medical systems*

Pacemakers- Need for Cardiac pacemaker - External Pace makers - Implantable Pace makers - recent developments in Implantable Pacemakers - Pacing system Analyzer - Defibrillators - Need for a Defibrillator - DC Defibrillator - Implantable Defibrillators - Pacer - Cardioverter - Defibrillator Analyzers - Physio therapy and electro therapy equipment- High frequency heat therapy - short wave diathermy- microwave and ultrasonic therapy - pain relief through electrical simulation.

Unit VI : *Biotelemetry*

Transmission and reception aspects of biological signals via long distances, Aspect of patient Care monitoring.

23.2 *Suggested books*

1. J S Webster, Medical Instrumentation-Application and Design.
2. L Cromwell, Biomedical instrumentation. PHL
3. R S Khandpur, Handbook of Biomedical Instrumentation, TMHN. Delhi, 1991.
4. B R Astor?Introduction to Biomedical Instrumentation and Measurement, MKeMillan.

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IAP-4056
Advanced Industrial Automation

Total Lectures : 42 **Credits : 6 (Theory : 06)**

Course Outcomes

- CO1: Explain different parameters required for process monitoring and control
- CO2: Describe the control devices as well as measuring and indicating devices
- CO3: Describe PLC, its hardware and programming techniques
- CO4: Elaborate DCS and SCADA

24.1 Theory

Unit I : *Process Variables*

Common process variables, process measurements, industrial sensors: optical, inductive, capacitive, encoders, ultrasonic, thermocouples.

Unit II : *Control Devices*

Overview of control devices: solenoid valve, control valve, actuators, pumps and motors, electrical drives, relays & contactors, pneumatic systems and hydraulic systems.

Measuring and indicating instruments: digital indicators, bar graph indicators, analog indicators, pen recorders, chartless recorders, indicating lamps & meters, alarms.

Unit III : *Programmable Logic Controller*

Programmable Logic Controller: overview, functions, features, applications, comparison with other controllers and selection process.

PLC hardware: modules of PLC, memory, Coils, contacts, timers and counters.

Unit IV : *PLC programming*

Configuration, ladder logic, function block diagram, structured text, sequential function chart, Instruction set: bit logic, compare, timer, counter, math, move, logical operations, conversion.

Unit V : *Distributed Control System*

Data acquisition basics, data control basics, DCS architecture, Supervisory Control & Data Acquisition (SCADA).

24.2 *Suggested books*

1. C.D Johnson, Process Control Instrumentation Technology, PHI
2. B. Wayne Bequette, Process Control: Modeling, Design, and Simulation, Prentice Hall Professional
3. Elvin Pérez Adrover, Introduction to PLCs: A beginner's guide to Programmable Logic Controllers
4. William Bolton, Programmable Logic Controllers

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IAP-4063
Instrumentation Lab-V

Total Lab sessions : 30 Credits : 3 (Lab : 03)

Course Outcomes

- CO1: Applications of different biomedical instruments
- CO2: Apply PLC for controlling different process parameters

25.1 List of experiments

Unit I : *Biomedical Instrumentation*

1. Study the characteristics of ECG 12-lead amplifier.
2. Simulate ECG signals for different Arrhythmia and analyse the signals.
3. Study the internal/ external pacemakers using pacemaker simulator.
4. Study the performance of a bio-telemetry system

Unit II : *Advanced Industrial Automation*

1. Write basic ladder diagram PLC programs and downloads to the PLC of the trainer kit PCST-14.
2. Write PLC programs to realise all logic gates.
3. Write PLC programs to use timers and counters.
4. Write a PLC program to control the conveyor belt system of the batch process reactor PCST 14-1.
5. Write a PLC program to control the batch process reactor PCST 14-1.

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IAP-4076
Project

Total sessions : 60 **Credits : 6 (Lab : 06)**

Course Outcomes

- CO1: Apply innovative and novel techniques for product development
- CO2: Compile an application of instrumentation through the developed product
- CO3: Generate a state of the art technique to address some regional issues
- CO4: Devise a product with real world importance