CHOICE BASED CREDIT SYSTEM

B. Sc. (HONOURS) Instrumentation

Syllabus and Scheme of Examination

for

B.Sc. (Honours) Instrumentation

Submitted

to

University Grants Commission
New Delhi

under

Choice Based Credit System

June 2015

Course Structure
Details of course under B.Sc. (Honours)

Course	*Credits	
	Theory+ Practical	Theory + Tutorial
I. Core Course		
(14 Papers)	14X4= 56	
Core Course Practical / Tutorial*		
(14 Papers)	14X2=28	
II. Elective Course		
(8 Papers)		
A.1. Discipline Specific Elective	4X4=16	
(4 Papers)		
A.2. Discipline Specific Elective Practical/ Tutorial*	4 X 2=8	
(4 Papers)		
B.1. Generic Elective/ Interdisciplinary	4X4=16	4X5=20
(4 Papers)		
B.2. Generic Elective Practical/ Tutorial*	4 X 2=8	4X1=4
(4 Papers)		
III. Ability Enhancement Courses		
1. **Ability Enhancement Compulsory Courses (AECC)**		
(2 Papers of 2 credit each)	2 X 2=4	2 X 2=4
Environmental Science		
English/MIL Communication		
2. **Skill Enhancement Courses (SEC)**		
(Minimum 2)	2 X 2=4	2 X 2=4
(2 Papers of 2 credit each)		
Total credit	**140**	**140**

- **Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester**

*** wherever there is a practical there will be no tutorial and vice-versa**

Policy about ECA/ General Interest/Hobby/Sports/NCC/NSS/related courses as per University of Delhi rules and norms

Scheme for Choice Based Credit System in B.Sc.(Honours) Instrumentation

	CORE - COURSE (14)	**Ability Enhancement Compulsory Course (AECC) (2)**	**Skill Enhancement Course (SEC) (2)**	**Elective: Discipline Specific DSE (4)**	**Elective: Generic (GE) (4)**
I	Basic Circuit Theory and Network Analysis	(English/ MIL Communication)/ Environmental Science			GE-1
	Applied Physics				
II	Analog Devices and Circuits	Environmental Science/(English/ MIL Communication)			GE-2
	Transducers and Sensors				
III	Biomedical Instrumentation		SEC -1		GE-3
	Digital Electronics and VHDL				
	Engineering Mathematics				
IV	Operational Amplifiers and Applications		SEC -2		GE-4
	Analytical Instrumentation				
	Electronic Instrumentation				
V	Measurement Technology			DSE-1	
	Microprocessor			DSE -2	
VI	Power Electronics			DSE -3	
	Control Systems			DSE -4	

SEMESTER-WISE SCHEDULE FOR B.Sc. (HONOURS) INSTRUMENTATION

Semester	Course Opted	Course Name	Credits
I	Ability Enhancement Compulsory Course-I	English/MIL communications/ Environmental Science	2
	Core course-I	Basic Circuit Theory and Network Analysis	4
	Core Course-I Practical/Tutorial	Basic Circuit Theory and Network Analysis Lab	2
	Core course-II	Applied Physics	4
	Core Course-II Practical/Tutorial	Applied Physics Lab	2
	Generic Elective -1	GE-1	4/5
	Generic Elective -1 Practical/Tutorial		2/1
II	Ability Enhancement Compulsory Course-II	English/MIL communications/ Environmental Science	2
	Core course-III	Analog Devices	4
	Core Course-III Practical/Tutorial	Analog Devices Lab	2
	Core course-IV	Transducers and Sensors	4
	Core Course-IV Practical/Tutorial	Transducers and Sensors Lab	2
	Generic Elective -2	GE-2	4/5
	Generic Elective -2 Practical/Tutorial		2/1
III	Core course-V	Biomedical Instrumentation	4
	Core Course-V Practical/Tutorial	Biomedical Instrumentation Lab	2
	Core course-VI	Digital Electronics and Verilog	4
	Core Course-VI Practical/Tutorial	Digital Electronics and Verilog Lab	2
	Core course-VII	Engineering Mathematics	4
	Core Course-VII Practical/Tutorial	Engineering Mathematics Lab	2
	Skill Enhancement Course-1	SEC-1	2
	Generic Elective -3	GE-3	4/5
	Generic Elective -3 Practical/Tutorial		2/1
IV	Core course-VIII	Operational Amplifiers and Applications	4
	Core Course-VIII Practical/Tutorial	Operational Amplifiers and Applications Lab	2
	Core course-IX	Analytical Instrumentation	4
	Core Course-IX Practical/Tutorial	Analytical Instrumentation Lab	2
	Core course-X	Electronic Instrumentation	4
	Core Course-X Practical/Tutorial	Electronic Instrumentation Lab	2
	Skill Enhancement Course-2	SEC-2	2
	Generic Elective -4	GE-4	4/5
	Generic Elective -4 Practical/Tutorial		2/1

V	Core course-XI	Measurement Technology	4
	Core Course-XI Practical/Tutorial	Measurement Technology Lab	2
	Core course-XII	Microprocessor	4
	Core Course-XII Practical/Tutorial	Microprocessor Lab	2
	Discipline Specific Elective-1	DSE-1	4
	Discipline Specific Elective-1 Practical/Tutorial	DSE-1 Lab	2
	Discipline Specific Elective-2	DSE-2	4
	Discipline Specific Elective-2 Practical/Tutorial	DSE-2 Lab	2
VI	Core course-XIII	Power Electronics	4
	Core Course-XIII Practical/Tutorial	Power Electronics Lab	2
	Core course-XIV	Control Systems	4
	Core Course-XIV Practical/Tutorial	Control Systems Lab	2
	Discipline Specific Elective-3	DSE-3	4
	Discipline Specific Elective-3 Practical/Tutorial	DSE-3 Lab	2
	Discipline Specific Elective-4	DSE-4	4
	Discipline Specific Elective-4 Practical/Tutorial	DSE-4 Lab	2
		Total Credits	140

CORE COURSE(C): (Credit: 06 each) (1 period/week for tutorials or 4 periods/week for practical)

1. Basic Circuit Theory and Network Analysis (4+4)
2. Applied Physics (4+4)
3. Analog Devices and Circuits (4+4)
4. Transducers and Sensors (4+4)
5. Biomedical Instrumentation (4+4)
6. Digital Electronics and Verilog (4+4)
7. Engineering Mathematics (4+4)
8. Operational Amplifiers and Applications (4+4)
9. Analytical Instrumentation (4+4)
10. Electronic Instrumentation (4+4)
11. Measurement Technology (4+4)
12. Microprocessors (4+4)
13. Power Electronics (4+4)
14. Control Systems (4+4)

Discipline Specific Electives (DSE): (Credit: 06 each) (4 papers to be selected) - DSE 1-4

1. Concepts of Chemistry (4+4)
2. Signal and Systems (4+4)
3. Advanced Analytical Instrumentation (4+4)
4. Communication System (4+4)
5. Advanced Biomedical Instrumentation (4+4)
6. Embedded System and Robotics (4+4)

7. Process Control Dynamics (4+4)
8. Reliability and Quality Control Techniques (4+4)
9. Dissertation (4+4)

Skill Enhancement Course (SEC) (02 papers) (Credit: 02 each) - SEC1 to SEC2

1. Programming in C (4)
2. VLSI Design and Verification (4)
3. Testing and Calibration (4)
4. PLC and SCADA (4)
5. Virtual Instrumentation (4)
6. Programming using MATLAB (4)

Other Discipline - GE 1 to GE 4

1. Mathematics
2. Computer Science
3. Physics
4. Biomedical Science
5. Chemistry
6. Electronics
7. Commerce

Any other discipline of Choice

Generic Elective Papers (GE) (Minor-Instrumentation) (any four) for other Departments/Disciplines: (Credit: 06 each)

1. Sensors and Actuators (4+4)
2. Electro-Mechanical Instruments(4+4)
3. Instrumentation & Control (4+4)
4. Analytical Instrumentation (4+4)
5. Nuclear & Biomedical Instrumentation (4+4)
6. Machine Intelligence (4+4)

Important:

1. The size of the practical group for practical papers is recommended to be 12-15 students.

Basic Circuit Theory and Network Analysis
(Credits: Theory-04, Practicals-02)

Theory Lectures 60

Unit- 1 **(13 Lectures)**

Basic Circuit Concepts: Voltage and Current Sources, Resistors: Fixed and Variable resistors, Construction and Characteristics, Color coding of resistors, resistors in series and parallel.
Inductors: Fixed and Variable inductors, Self and mutual inductance, Faraday's law and Lenz's law of electromagnetic induction, Energy stored in an inductor, Inductance in series and parallel, Testing of resistance and inductance using multimeter.
Capacitors: Principles of capacitance, Parallel plate capacitor, Permittivity, Definition of Dielectric Constant, Dielectric strength, Energy stored in a capacitor, Air, Paper, Mica, Teflon, Ceramic, Plastic and Electrolytic capacitor, Construction and application, capacitors in series and parallel, factors governing the value of capacitors, testing of capacitors using multimeter.

Unit- 2 **(13 Lectures)**

Circuit Analysis: Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis, Star-Delta Conversion.
DC Transient Analysis: Initially Charged RC Circuit, RL Circuit with Initial Current, Time Constant, RL and RC Circuits With Sources, DC Response of Series RLC Circuits.

Unit-3 **(18 Lectures)**

AC Circuit Analysis: Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Voltage-Current relationship in Resistor, Inductor and Capacitor, Phasor, Complex Impedance, Power in AC Circuits: Instantaneous Power, Average Power, Reactive Power, Power Factor. Sinusoidal Circuit Analysis for RL, RC and RLC Circuits. Mesh Analysis, Node Analysis and Network Theorems for AC Circuits.
Resonance in Series and Parallel RLC Circuits, Frequency Response of Series and Parallel RLC Circuits, Quality (Q) Factor and Bandwidth. Passive Filters: Low Pass, High Pass, Band Pass and Band Stop.

Unit-4 **(16 Lectures)**

Network Theorems: Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem.
Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters, Transmission (ABCD) Parameters.

Suggested books:

1. S. A. Nasar, Electric Circuits, Schaum's outline series, Tata McGraw Hill (2004)
2. Electrical Circuits, M. Nahvi and J. Edminister, Schaum's Outline Series, Tata McGraw-Hill.(2005)
3. Robert L. Boylestad, Essentials of Circuit Analysis, Pearson Education (2004)
4. W. H. Hayt, J. E. Kemmerly, S. M. Durbin, Engineering Circuit Analysis, Tata McGraw Hill(2005)
5. Alexander and M. Sadiku, Fundamentals of Electric Circuits , McGraw Hill (2008)

Basic Circuit Theory and Network Analysis Lab (Hardware and Circuit Simulation Software)
60 Lectures

1. Familiarization with
a) Resistance in series, parallel and series – Parallel.
b) Capacitors & Inductors in series & Parallel.
c) Multimeter – Checking of components.
d) Voltage sources in series, parallel and series – Parallel
e) Voltage and Current dividers

2. Measurement of Amplitude, Frequency & Phase difference using CRO.
3. Verification of Kirchoff's Law.
4. Verification of Norton's theorem.
5. Verification of Thevenin's Theorem.
6. Verification of Superposition Theorem.
7. Verification of the Maximum Power Transfer Theorem.
8. RC Circuits: Time Constant, Differentiator, Integrator.
9. Designing of a Low Pass RC Filter and study of its Frequency Response.
10. Designing of a High Pass RC Filter and study of its Frequency Response.
11. Study of the Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Band Width.

Applied Physics
(Credits: Theory-04, Practicals-02)

Theory Lectures 60

Unit 1 **(13 Lectures)**

Thermodynamics: Heat and Temperature, Zeroth law of thermodynamics: thermal equilibrium, thermometry and temperature scales, First law of thermodynamics, Thermodynamic systems and processes, Internal energy and heat capacity, adiabatic processes. Second law of thermodynamics, Reversible and irreversible processes.

Unit 2 **(22 Lectures)**

Interference: Interference of light, Bi prism experiment, displacement of fringes, interference in thin films- wedge shaped film, Newton's rings.
Diffraction - Single, Double & N- Slit, Diffraction grating, Grating spectra, Rayleigh's criterion and resolving power of grating.
Polarization- Phenomena of double refraction, Nicol prism, Production and analysis of plane, circular and elliptical polarized light, Fresnel's theory of optical activity, Polarimeters.
Laser: Basic principle, Spontaneous and stimulated emission of radiation, Einstein's Coefficients, Laser applications.
Fibre Optics: Principles and applications

Unit 3 **(12 Lectures)**

Nuclear Physics: Nucleus, constituent of nucleus, Properties of Nucleus size, mass, density, energy, charge, binding energy, nuclear angular momentum, Nuclear force.

Unit 4 **(13 Lectures)**

Fluid Mechanics: Fluid properties; Surface Tension, Viscosity, equation, Bernoullis equation; Navier-Stokes Equations; Differential form of Energy equation. Reynold number, Incompressible and compressible Flow, Laminar and turbulent flows, Flow through pipes

Suggested books:

1. Ajoy Ghatak –Optics, fourth Edition, McGraw-Hill
2. M.W. Zemansky and R.H. Dittman- Heat and Thermodynamics (Mc-Graw Hill)
3. Nuclear physics by Cohen
4. Fox and Mc Donald- Introduction to Fluid Mechanics
5. Aurthur Beiser -Concepts of Modern Physics - (Mc-Graw Hill)
6. Anuradha De. -Optical Fibre & Laser (New Age)
7. Resnick, Halliday & Walker -Fundamental of Physics - (Wiley)
8. R.A. Serway & J.W. Jewett -Principles of Physics
9. H.Callen-Thermodynamics and an Introduction to Thermo statistics (Wiley, New York).

Applied Physics Lab
60 Lectures

1. To determine the thermal conductivity of a good conductor by Searl's method.
2. Determination of J, mechanical equivalent of heat by calendar and Barne's method.
3. To determine the temperature coefficient of PRT (Platinum Resistance Thermometer).
4. To determine the dispersive power of prism using spectrometer and mercury source.
5. To determine the refractive index of a prism using spectrometer
6. To determine the wavelength of sodium light by Newton's Ring.
7. To find the wavelength of He-Ne Laser using transmission diffraction grating.
8. To find the thermal conductivity of poor conductors by Lee Disc Method

Analog Devices and Circuits
(Credits: Theory-04, Practicals-02)

Theory Lectures: **60**

Unit-1 **(16 Lectures)**

Semiconductor Basics: Introduction to semiconductor materials, intrinsic & extrinsic semiconductors. p-n junction diode**:** Ideal diode, Formation of depletion layer, space charge at a junction, Diode Circuits: clipper circuits, clamping circuits. Half wave rectifier, Center tapped and bridge full wave rectifiers, calculation of efficiency and ripple factor. DC power supply: Block diagram of a power supply, Zener diode as voltage regulator, temperature coefficient of Zener diode.

Unit-2 **(15 Lectures)**

The BJT: basic transistor action, Transistor current components and amplification. Transistor configurations: Common Base (CB), Common Emitter (CE) and Common Collector (CC) configuration, I-V characteristics and hybrid parameters, regions of operation, dc load line, Q point. CE amplifier: Self bias arrangement of CE, dc and ac load line analysis, Hybrid equivalent of CE, frequency response of CE amplifier.

Unit- 3 **(14 Lectures)**

Feedback Amplifiers: Concept of feedback, negative and positive feedback, Negative feedback: advantages and disadvantages of negative feedback, voltage (series and shunt), current (series and shunt) feedback amplifiers, derivation of gain, input and output impedances for feedback amplifiers. Positive feedback: Barkhausen criteria for oscillations, Study of phase shift oscillator, Colpitts oscillator and Crystal oscillator.

Unit-4 **(15 Lectures)**

Junction Field Effect Transistor (JFET): Construction of JFET, idea of channel formation, pinch-off and saturation voltage, current-voltage output characteristics. Metal Oxide Field Effect Transistor (MOSFET): The ideal MOS diode, accumulation, depletion and inversion, Basic Construction of MOSFET and working, I-V characteristics, enhancement and depletion modes. Complimentary MOS (CMOS), MOSFET amplifier
UJT: construction, working and applications.

Suggested books:

1. R. L. Boylestad, L. Nashelsky, K. L. Kishore, Electronic Devices and Circuit Theory, Pearson Education (2006).
2. N Bhargava, D C Kulshreshtha and S C Gupta, Basic Electronics and linear circuits, Tata McGraw-Hill (2007)
3. J. Millman and C. Halkias, Integrated Electronics, Tata McGraw Hill (2001).
4. David A. Bell, Electronic Devices & Circuits, Oxford University Press, Fifth edition
5. Mottershed, Electronic Devices, PHI Publication, 1st Edition.
6. D. L. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill (2002).
7. J. R. C. Jaegar and T. N. Blalock, Microelectronic Circuit Design, Tata McGraw Hill (2010).
8. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill (2002).
9. J. Cathey, 2000 Solved Problems in Electronics, Schaum's outline Series, Tata McGraw Hill (1991).

Analog Devices and Circuits Lab
60 lectures

1. To study the Half wave rectifier and Full wave rectifier.
2. To study power supply using C filter and zener diode.
3. To study Fixed Bias and Voltage divide Feedback configuration for transistor.
4. To design a Single Stage CE amplifier.
5. To study Class A, B and C Power Amplifier.
6. To study clipping circuits
7. To study clamping circuits
8. To study the Colpitt's Oscillator.
9. To study the Phase Shift Oscillator.
10. To study the frequency response of Common Source FET amplifier.

Transducers and Sensors
(Credits: Theory-04, Practicals-02)

Theory Lectures 60

Unit- 1 **(16 Lectures)**

Basic concepts of Instrumentation: generalized instrumentation systems block diagram representation, scope of instrumentation in Industrial organization.
Measurement systems: static (accuracy, sensitivity, linearity, precision, resolution, threshold, range, hysteresis, dead band, backlash, drift), impedance matching and loading, dynamic characteristics (types, fidelity, speed of response, dynamic error).

Unit-2 **(8 Lectures)**

Definition of errors- systematic errors, instrumental errors, environmental errors, random errors, loading errors, random errors, source of errors in measuring instruments, Uncertainties types, propagation of uncertainties)

Unit- 3 **(20 Lectures)**

Transducers - Classification, Active, Passive, Mechanical, Electrical, their comparison. Selection of Transducers, Principle and working of following types: Displacement transducers - Resistive (Potentiometric, Strain Gauges – Types, Gauge Factor, bridge circuits, Semi-conductor strain gauge) Capacitive (diaphragm), Inductive (LVDT-Principle and characteristics, Hall effect sensors, magneto-strictive transducers).

Unit- 4 **(16 Lectures)**

Piezoelectric (Element and their properties, Piezo Electric coefficients. Equivalent circuit and frequency response of P.E. Transducers), light (photo-conductive, photo emissive, photo voltaic, semiconductor, LDR), Temperature (electrical and non-electrical). Pressure (force summing devices, load cell)

Suggested Books:

1. Doeblin& Manek, Measurement Systems, 4/e, McGraw Hill, New York, 1992,5th edition
2. Nakra & Choudhary ,Instrumentation Measurements and Analysis , Tata McGraw-Hill, 2nd edition
3. A.K. Sawhney , Electrical & Electronic Measurements & Instrumentation, 19th revised edition
4. Rangan, Sarma, and Mani, Instrumentation- Devices and Systems ,Tata-McGraw Hill 2nd edition
5. H.S Kalsi, Electronic Instrumentation ,McGraw Hill, 4th edition
6. DVS Murthy, Measurement & Instrumentation, PHI
7. D. Patranabis, Sensors and Transducers, PHI, 2nd edition
8. Arun K. Ghosh, Introduction to Measurements and Instrumentation, PHI, 4th edition

Transducers and Sensors Lab
60 Lectures

1. Measurement of pressure, strain and torque using strain gauge.
2. Measurement of speed using Electromagnetic transducer.
3. Measurement of speed using photoelectric transducers
4. Measurement of angular displacement using Potentiometer.
5. Measurement of displacement using LVDT.
6. Measurement using load cells.
7. Measurement using capacitive transducer.
8. Measurement using inductive transducer.
9. Measurement of Temperature using Temperature Sensors/RTD.
10. Characteristics of Hall effect sensor.
11. Measuring change in resistance using LDR.

Biomedical Instrumentation
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit-1 **(16 Lectures)**

Biopotentials, Bioamplifiers and Bioelectrodes: Introduction to bio-electric potential, bio-amplifier, components of man Instrument system, types of biomedical systems, design factors and limitations of biomedical instruments, terms and transducers to measure various physiological events, types of bio-potential electrodes (Body surface electrodes, Internal electrodes, Micro electrodes), electrolyte interface, electrode circuit model, impedance and polarization, Properties of electrodes .

Unit- 2 **(17 Lectures)**

Cardiac vascular system & measurements: ECG: origin, Instrumentation, bipolar system lead system I, II, III, Einthovan's triangle, Augmented lead system, unipolar chest lead system, types of display. Blood pressure measurements: direct, indirect. Defibrillators: AC, DC. Pacemakers- Internal, External. Blood Flow meters: Electromagnetic blood flow meter, ultrasonic blood flow meter. Oximeters: Different types of oximetry systems, pulse oximeter.

Unit- 3 **(15 Lectures)**

Respiratory Measurement Systems: Types of volume, types of measurements, Instrumentation of respiratory system, principle & types of pneumograph, Spirometer, pneumotachometers, nitrogen wash out technique. Ventilators: Basic principles of ventilators, different generators, inspiratory phase and expiratory phase, types of ventilators

Unit- 4 **(12 Lectures)**

Nervous system: Action potential of brain, brain wave, Instrumentation of Electroencephalography (EEG), electrodes used for recording EEG analysis.
Medical Imaging system: -Thermal imaging system, working, IR detectors, applications. Radiography-conventional X-ray, properties, generation of X-ray, Fluoroscopy

Suggested Books:

1. Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Second edition, Prentice Hall (2010), 2nd edition
2. Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Fourth edition, Pearson Education Inc (2010), 2nd edition
3. Khandpur R.S., Handbook of Biomedical Instrumentation, Second edition, Tata McGraw-Hill Publishing (2009), 2nd edition
4. Joseph D. Bronzino, The Biomedical Engineering Handbook, IEEE Press (2000), 2nd edition, Volume 1.
5. Richard Aston, Principles of Biomedical Instrumentation & Measurement, Merrill Publishing Company, (1990), 1st edition
6. Mandeep Singh, Introduction to Biomedical Instrumentation, PHI learning private limited (2010), 1st edition

Biomedical Instrumentation Lab
60 Lectures

1 .Characterization of bio potential amplifier for ECG signals.
2. Study on ECG simulator
3. Measurement of heart sound using electronic stethoscope. Study on ECG heart rate monitor /simulator
4 .Study of pulse rate monitor with alarm system
5. Determination pulmonary function using spirometer (using mechanical system).
6. Measurement of respiration rate using thermister /other electrodes.
7. Study of Respiration Rate monitor/ apnea monitor
8. Study on ultrasound transducers based on medical system
9. Study of a Pacemaker.
10. Measurement of pulse rate using photoelectric transducer & pulse counting for known period.

Digital Electronics and VHDL
(Credits: Theory-04, Practicals-02)

Theory Lectures 60

Unit-1 **(11 Lectures)**

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, octal and hexadecimal arithmetic (addition, subtraction by complement method, multiplication), representation of signed and unsigned numbers, Binary Coded Decimal code.
Logic Gates and Boolean algebra: Truth Tables of OR, AND, NOT, XOR, XNOR, Universal (NOR and NAND) Gates, Basic postulates and fundamental theorems of Boolean algebra.
Digital Logic families: Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed power product, comparison of TTL and CMOS families.

Unit-2 **(13 Lectures)**

Combinational Logic Analysis and Design: Standard representation of logic functions (SOP and POS), Karnaugh map minimization, Encoder and Decoder, Multiplexers and Demultiplexers, Implementing logic functions with multiplexer, binary Adder, binary subtractor, parallel adder/subtractor.

Unit-3 **(16 Lectures)**

Sequential logic design: Latches and Flip flops , S-R Flip flop, J-K Flip flop, T and D type Flip flops, Clocked and edge triggered Flip flops, Registers, Counters (synchronous and asynchronous, ring and modulo-N), State Table, State Diagrams, counter design using excitation table and equations.

Unit-4 **(20 Lectures)**

Programmable Logic Devices: Basic concepts- ROM, PLA, PAL, CPLD, FPGA
Introduction to VHDL: A Brief History of HDL, Structure of HDL Module, Comparison of VHDL and Verilog, Introduction to Simulation and Synthesis Tools, Test Benches. VHDL Modules, Delays, data flow style, behavioral style, structural style, mixed design style, simulating design.
Introduction to Language Elements, Keywords, Identifiers, White Space Characters, Comments, format, Integers, reals and strings. Logic Values, Data Types-net types, undeclared nets, scalars and vector nets, Register type, Parameters. Expressions, Operands, Operators, types of Expressions
Gate level modeling - Introduction, built in Primitive Gates, multiple input gates, Tri-state gates, pull gates, MOS switches, bidirectional switches, gate delay, array instances, implicit nets, Illustrative Examples (both combinational and sequential logic circuits).

Suggested Books:

1. M. Morris Mano Digital System Design, Pearson Education Asia,(Fourth Edition)
2. Thomas L. Flyod, Digital Fundamentals, Pearson Education Asia (1994)
3. W. H. Gothmann, Digital Electronics: An Introduction To Theory And Practice, Prentice Hall of India(2000)
4. R. L. Tokheim, Digital Principles, Schaum's Outline Series, Tata McGraw- Hill (1994)
5. A Verilog HDL Primer – J. Bhasker, BSP, 2003 II Edition.
6. Verilog HDL-A guide to digital design and synthesis-Samir Palnitkar, Pearson, 2nd edition.

Digital Electronics and VHDL Lab (Hardware and Circuit Simulation Software)
60 lectures

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.
2. To convert a Boolean expression into logic gate circuit and assemble it using logic gate IC's.
3. Design a Half and Full Adder.
4. Design a Half and Full Subtractor.
5. Design a seven segment display driver.
6. Design a 4 X 1 Multiplexer using gates.
7. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type).
8. Design a counter using D/T/JK Flip-Flop.
9. Design a shift register and study Serial and parallel shifting of data.

Experiments in VHDL

1. Write code to realize basic and derived logic gates.
2. Half adder, Full Adder using basic and derived gates.
3. Half subtractor and Full Subtractor using basic and derived gates.
4. Clocked D FF, T FF and JK FF (with Reset inputs).
5. Multiplexer (4x1, 8x1) and Demultiplexer using logic gates.
6. Decoder (2x4, 3x8), Encoders and Priority Encoders.
7. Design and simulation of a 4 bit Adder.
8. Code converters (Binary to Gray and vice versa).
9. 2 bit Magnitude comparator.
10. 3 bit Ripple counter.

Engineering Mathematics
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit- 1 **(18 Lectures)**

Differential Equations: Ordinary differential Equations, Linear Independence and Dependence, Linear Differential Equations of Second Order with Variable Coefficients, Second Order Differential Equations with Constant Coefficients: Homogeneous, Non-Homogeneous Equations, Differential Equation with Variable Coefficients: Reducible to Equations with Constant Coefficients, Method of Variation of Parameters, Electric Circuits, System of Simultaneous Linear Differential Equations with Constant Coefficients.

Unit- 2 **(14 Lectures)**

Partial Differential Equations: Formation of Partial Differential Equation, Partial Differential Equation of First Order, Linear Equations of First Order, Non-linear Partial Differential Equations of First Order, Method of Separation of Variables, Classification of Partial Differential Equations of Second Order. Convolution theorem, Impulse Function and Unit Step function, solutions to ordinary differential equations. Initial and Final value theorem.

Unit- 3 **(12 Lectures)**

Laplace Transform: Laplace Transform and its properties, Convolution theorem, Impulse Function and Unit Step function, solutions to ordinary differential equations. Initial and Final value theorem, system of differential equations, Laplace transforms. Modeling a Vibrating string and the Wave Equation, Separation of Variables, Inverse Laplace transforms and their properties.

Unit- 4 **(16 Lectures)**

Fourier series and Transforms: Functions of any period, even and odd Functions, half range expansions, Forced Oscillations, Complex Fourier Series Fourier Integral, Fourier Sine and Cosine Transforms. , Fourier Transforms, Discrete and Fast Fourier Transforms. Fourier integrals, Modeling a Vibrating string and the Wave Equation, Separation of Variables and Use of Fourier series.

Suggested Books:

1. E. Kreyszig, Advanced Engineering Mathematics, Wiley India (2008), 8th Edition
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Publishing Company Limited (2007), 6th reprint
3. Michel D Greenberg; Advanced Engineering Mathematics, Pearson International
4. R. K. Jain, and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House (2007), 3rd edition
5. C .R. Wylie and L. C. Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill (2004)
6. A.S.Willsky, Oppenheim, Signals and System, Prentice Hall, 2nd edition
7. B.S. Grewal; Higher Engineering Mathematics, Khanna Publishers

Engineering Mathematics lab (**using Scilab /MATLAB/ any other Mathematical Simulation software**) **(60 Lectures)**

1. Solve the linear differential equation of second order with variable coefficients.
2. Solve the linear differential equation of second order with constant coefficients.
3. Plot curves like sin x, cos x, tan x, log x, exp(x), x^2, x^3, x+x^2+exp(x).
4. Computing Fourier of a given signal.
5. Laplace Transform of a given signal.

Operational Amplifiers and Applications
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit- 1 **(18 Lectures)**

Basic Operational Amplifier: Concept of differential amplifiers (Dual input balanced and unbalanced output), constant current bias, current mirror, cascaded differential amplifier stages with concept of level translator, block diagram of an operational amplifier (IC 741)
Op-Amp parameters: input offset voltage, input offset current, input bias current, differential input resistance, input capacitance, offset voltage adjustment range, input voltage range, common mode rejection ratio, slew rate, supply voltage rejection ratio.

Unit- 2 **(18 Lectures)**

Op-Amp Circuits: Open and closed loop configuration, Frequency response of an op-amp in open loop and closed loop configurations, Inverting, Non-inverting, Summing and difference amplifier, Integrator, Differentiator, Voltage to current converter, Current to voltage converter.
Comparators: Basic comparator, Level detector, Voltage limiters, Schmitt Trigger.
Signal generators: Phase shift oscillator, Wein bridge oscillator, Square wave generator, triangle wave generator, saw tooth wave generator, and Voltage controlled oscillator(IC 566).

Unit- 3 **(12 Lectures)**

Multivibrators (IC 555): Block diagram, Astable and monostable multivibrator circuit, Applications of Monostable and Astable multivibrators. Phase locked loops (PLL): Block diagram, phase detectors, IC565.
Fixed and variable IC regulators: IC 78xx and IC 79xx -concepts only, IC LM317- output voltage equation

Unit- 4 **(12 Lectures)**

Signal Conditioning circuits: Sample and hold systems, Active filters: First order low pass and high pass butterworth filter, Second order filters, Band pass filter, Band reject filter, All pass filter, Log and antilog amplifiers.

Suggested Books:

1. R. A. Gayakwad, Op-Amps and Linear IC's, Pearson Education (2003)
2. R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits, Pearson Education (2001)
3. J. Millman and C.C. Halkias, Integrated Electronics, Tata McGraw-Hill,(2001)
4. A.P.Malvino, Electronic Principals,6th Edition , Tata McGraw-Hill,(2003)
5. K.L.Kishore,OP-AMP and Linear Integrated Circuits, Pearson(2011)

Operational Amplifiers and Application Lab (Hardware and Circuit Simulation Software)
60 Lectures

1. Study of op-amp characteristics: CMRR and Slew rate.
2. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an op-amp.
3. Designing of analog adder and subtractor circuit.
4. Designing of an integrator using op-amp for a given specification and study its frequency response.
5. Designing of a differentiator using op-amp for a given specification and study its frequency response.
6. Designing of a First Order Low-pass filter using op-amp.
7. Designing of a First Order High-pass filter using op-amp.
8. Designing of a RC Phase Shift Oscillator using op-amp.
9. Study of IC 555 as an astable multivibrator.
10. Study of IC 555 as monostable multivibrator.
11. Designing of Fixed voltage power supply using IC regulators using 78 series and 79 series

Analytical Instrumentation
(Credits: Theory-04, Practicals-02)

Theory Lectures 60

Unit- 1 **(20 Lectures)**

Molecular Spectro-analytical Methods of Analysis: Colorimetry and Spectrophotometry: Introduction, theory: molecular energy levels, types of molecular transitions, Lambert-Beer's Law and limitations, types of sources, monochromators and detectors, Instrumentation of single beam and double beam instrument.
Infrared Spectroscopy: Theory, diatomic molecules as a simple harmonic oscillator, instrumentation, sample handling techniques. Fourier Transform Infrared Spectroscopy (FTIR): advantages, instrumentation qualitative and quantitative applications, interpretation of Infrared (IR) spectra.

Unit- 2 **(10 Lectures)**

Atomic Spectroscopy: Principle, comparison of atomic and molecular spectroscopy, atomic transitions, atomic absorption, atomisation process, types of flames- fuel/ oxidant combinations, instrumentation of spectrophotometers; Interferences: spectral, chemical and ionization; applications. Atomic emission spectroscopy (AES): Flame photometer and its instrumentation, analysis using standard addition method, applications.

Unit- 3 **(14 Lectures)**

Separation methods: Theory of chromatography; instrumentation and applications of Thin layer chromatography (TLC). **Column chromatography**: Principle, process of elution through a column, chromatogram, band broadening, capacity factor, selectivity factor , Column efficiency, number of plates, plate height, column resolution.

Unit- 4 **(16 Lectures)**

Gas Chromatography (GC): carrier gases, different type of injection systems, columns, stationary phases and detectors. Isothermal mode, temperature programming mode, analysis by internal standard method, applications. **High Performance Liquid Chromatography (HPLC):** mobile phase, isocratic and gradient elution, pumps, injection systems, columns, stationary phases, normal phase and reverse phase chromatography, detectors and their application.

Suggested Books:

1. Skoog & Lerry, Instrumental Methods of Analysis, Saunders College Publications, New York
2. H.H.Willard, Instrumental Methods of Analysis, CBS Publishers.
3. D.C. Harris, Quantitate Chemical Analysis, W.H.Freeman
4. Christian G.D, Analytical Chemistry, John & Sons, Singapore
5. Skoog, West and Holler, Analytical Chemistry, Saunders College Publications, New York
6. Vogel's Textbook of Qualitative Chemical Analysis, ELBS
7. J.A. Dean, Analytical Chemistry Notebook, McGraw Hill
8. John H. Kennedy, Analytical Chemistry: Principles, Saunders College Publication
9. W. Kemp, Organic Spectroscopy, ELBS
10. Hand book of Instrumental Techniques for Analytical Chemistry, Frank Settle, editor, Prentice Hall

Analytical Instrumentation Lab
(60 Lectures)

1. Determination of pKa value for a dye using double beam spectrophotometer.
2. Spectrometric determination of iron in water sample using double beam spectrophotometer.
3. Determination of concentrations of sodium, calcium, lithium and potassium in sample using flame photometer.
4. Determination of concentration of potassium ions in sample by standard addition method using flame photometer
5. Spectrum interpretation using FT-IR.
6. Analysis of various ions using atomic absorption system.
7. Thin layer chromatographic (TLC) separation of samples from different origin
8. (Biological / Pharmaceutical / Food).
9. Qualitative analysis of samples using Gas chromatography
10. Qualitative analysis of samples using High Performance Liquid Chromatography.

Electronic Instrumentation
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit- 1 **(18 Lectures)**

DC and AC Measurement: DC and AC indicating Instruments: Accuracy and precision - Types of errors, Basic Measurement Instruments-DC Bridges and applications: Wheatstone, Kelvin, AC Bridges: General form of AC bridge balance, comparison bridges, Maxwell, Hay, Schering, Wien, Wagner ground condition.
DC measurement: DC voltmeter, ammeter, ohmmeter, multimeter, AC measurement: voltmeter, ammeter. Digital type voltmeters, digital multimeter, Digital LCR meter. Digital frequency meter: Elements of frequency meter, universal counter and its different modes, measurement errors and extending the frequency range.

Unit- 2 **(14 Lectures)**

Signal Generators-Types of generators and their operation: Audio oscillator, Function generators, Pulse generators, RF generators, Random noise generators, Sweep generator. Probes and Connectors: Test leads, shielded cables, connectors, low capacitance probes, high voltage probes, RF demodulator probes, special probes for IC's, current probes.

Unit- 3 **(16 Lectures)**

Electronic Displays: Cathode Ray Oscilloscope (CRO) and applications: Block diagram of a General Purpose Oscilloscope and its basic operation, electrostatic focusing and deflection, screens for CRT and graticules, CRT Connections, CRO probes. Types of CRO's: dual trace oscilloscope, digital storage oscilloscope, Sampling oscilloscope. Amplitude, Frequency, Phase measurements, Lissajous Figures.

Unit- 4 **(12 Lectures)**

Spectrum Analyser and Wavemeter: Frequency Spectrum, Distortion and wave measurement - Spectrum analyzer, Harmonic distortion analyzer, Intermodulation distortion analyzer, wave analyzer and distortion factor meter, wave meter, Different type of wave meters: Lumped and cavity wavemeters, Q-meter and its applications.

Suggested books:

1. H. S. Kalsi, Electronic Instrumentation, Tata McGraw Hill (2006)
2. Joseph J Carr, Elements of electronic instrumentation and measurement, Pearson Education (2005)
3. C. S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata McGraw Hill (1998)
4. H. Cooper, Modern electronic instrumentation and measurement techniques, Pearson Education (2005)
5. 5. R. A. Witte, Electronic test instruments: Analog and digital measurements, Tata McGraw Hill (2004)
6. 6. S. Wolf and R. F. M. Smith, Student Reference Manual for Electronic Instrumentation Laboratories, Pearson Education (2004)

Electronic Instrumentation Lab
(60 Lectures)

1. Study and operation of Multimeters (Analog and Digital), Function Generator, Regulated Power Supplies, CRO.
2. Study the generation of Lissajous figures to find unknown frequency and phase shift.
3. Frequency measurement using Wein Bridge.
4. Study of R, L, C and Q meter.
5. Study of DSO-Measurement of response time of relay using DSO.
6. Measurements of L, C, R using bridges.
7. To study bridge based loop tests.
8. Study of Universal Counter

Measurement Technology
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit- 1 **(22 Lectures)**

Flow Measurement: Introduction, definitions and Units, classification of flow meters, Mechanical type flowmeters, Theory of fixed restriction variable head type flow meters, orifice plate, venturi tube, flow nozzle, dall tube, installation of head flow meters Quantity meters, area flow meters and mass flow meters, Positive displacement flow meters, constructional details and theory of operation of mutating disc, reciprocation piston, oval gear and helix type flow meters, inferential meter, turbine flow meter, rotameter, thermal mass flow meter, volume flow meter plus density measurement, Electrical type flow meter, Principle and constructional details of electromagnetic flow meter, different types of excitation , schemes used different types of ultrasonic flow meters, laser doppler anemometer systems , rortex shedding flow meter, target flow meter, solid flow rate measurement , guidelines for selection of flow meter.

Unit- 2 **(15 Lectures)**

Measurement of Speed and Acceleration: Tachometers, Mechanical, Electric, Contact less, Frequency, Ignition, Stroboscopic tachometers. Accelerometers, Elementary, Seismic and Practical accelerometers.
Recorders : Types, strip chart, circular, X,Y, oscillographic, magnetic tape, printers, dot matrix, ink jet, laser

Unit 3 **(08 Lectures)**

Measurement of Humidity and Moisture: Basic principles, hygrometers, psychrometers , humidity charts , dew point, measurement systems for humidity., Infrared moisture measuring systems , radioactive moisture measuring systems.

Unit 4 **(15 Lectures)**

Pressure measurement: Units of pressure, manometers, different types, elastic type pressure gauges, Bourde type bellows, diaphragms, measurement of vacuum, McLeod gauge, Pirani and Ionisation Gauge, thermal conductivity gauges, Ionization gauge cold cathode and hot cathode types – testing and calibration of pressure gauges, dead weight tester. Vacuum pumps, Rotary and Diffusion.

Suggested Books:

1. Process Measurement and Analysis, 4th Edition (1995), Liptak B. G., Chilton Book Company, Pennsylvania.
2. Principles of Industrial Instrumentation, 2nd Edition (1997), D.Patranabis, Tata McGraw Hill Publishing Co., New Delhi.
3. A Course in Electrical and Electronic Measurements and Instrumentation, (2005), A.K. Sawhney, Dhanpat Rai & Co.
4. Mechanical and Industrial Measurements, Tenth Edition (1996), R.K. Jain, Khanna Publishers.
5. Measurement Systems: Application and Design, Fourth Edition (1992), Doeblin E. O, McGraw Hill, Singapore.

Measurement Technology Lab
(60 Lectures)

1. Flow rate measurement using orifice plate flowmeter.
2. Calibration of pressure gauge using dead weight calibrator.
3. Experiment on working of thermocouple.
4. Experiment on control of various functions using RTD.
5. To find out level of water using level transmitters.
6. Measurement of conductivity of test solutions using electrical conductivity meter.
7. EM flowmeter and ultrasonic flowmeter.
8. Ratio control in combustion laboratory Unit.
9. AC/DC meter calibrator.
10. To study of Circular chart recorder

Microprocessors
(Credits: Theory-04, Practicals-02)

Theory Lectures 60

Unit- 1 **(18 Lectures)**

8085 Microprocessor: Introduction to 8085 Microprocessor, Pin description of 8085, Architecture, register of 8085, addressing mode. Instruction Type and Instruction Set, Machine Cycle, Instruction Cycle, Timing Diagram.
Memory System, internal and external memory and concept of Virtual Memory. Hardware Interfacing or Types of I/O addressing-Interfacing Memory and Peripheral (I/o Mapped I/O and memory mapped I/O).

Unit-2 **(10 Lectures)**

Assembly Language Programming Stacks and Subroutine, Interrupts of 8085-Hardware and Software interrupts. Difference between RISC and CISC Processor

Unit- 3 **(18 Lectures)**

Interfacing ICs, Programmable Peripheral Interface: Intel 8155, 8253, 8255, programmable Interrupt Controller: Intel 8259

Unit- 4 **(14 Lectures)**

Application of Microprocessor 8085 in Instrumentation: Interfacing of Stepper Motor,
Introduction to 8086 Microprocessor: keyboard Basics of 8086 (16 bit Microprocessor), Architecture of 8086, Concept of parallel processing in 8086.

Suggested Books:

1. Ramesh Gaonkar, Microprocessors architecture, programming and Applications, Wiley Eastern Ltd. (2002), 2nd Edition
2. P.K Ghosh& P.R Sridhar, 0000 to 8085 microprocessor, John Wiley & Sons, 2nd Edition
3. Liu Gibson, Microprocessor Systems: The 8086/8088 family Architecture, Programming& Design, PHI, 1999, 2nd Edition
4. R. Thegarajan and S. Dhanpal, Microprocessor and its Application, New Age International Private Ltd, 1st Edition
5. K. Udaya Kumar & B.S. Uma Shankar, The 8085 Microprocessor: Architecture, Programming and Interfacing", Pearson Education
6. Barry B. Brey and C R Sarma, The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80606,
7. Pentium and Pentium Pro-Processor Architecture, Programming and Interfacing, Pearson Education, (2005)
8. Walter Triebel &Avtar A.Singh, 8088 and 8086 Microprocessors: Programming, Interfacing, Software Hardware and Applications, Pearson Education, 4th edition
9. D. V. Hall, "Microprocessors and Interfacing", Tata McGraw Hill (2005), revised 2nd edition

Microprocessor Lab
(60 Lectures)

1. To write an assembly language program to perform basic mathematical operations (addition, subtraction, multiplication, division)
2. To write an assembly language program to generate first N terms of an A.P. / G.P. series
3. To write an assembly language program to generate first N terms of Fibonacci series
4. To write an assembly language program to arrange the given list of number in ascending /
5. descending order
6. To write an assembly language program to calculate N!
7. To write an assembly language program to separate prime numbers in a given list of number
8. To write an assembly language program to convert a number from one number system to
9. another.
10. To write an assembly language program to design a clock 36
11. To write an assembly language program to calculate a mathematical expression
12. (for e.g. 2N/N!)
13. To write an assembly language program to calculate value of sin(x)
14. To implement basic 8086 interrupts using assembler

Power Electronics
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit- 1 **(14 Lectures)**

Basic Power Devices and Circuits: SCR, Diacs and Triacs, Two transistor model of SCR, Resistive and RC triggering circuits. Applications of SCR: Basic series inverter circuit, Chopper circuit – Basic concept, step up and step down choppers.

Unit- 2 **(18 Lectures)**

Types of motors and Motor Drives: Constructional features and characteristics of DC Motors, AC Motors, Induction Motors, Single and three phase Motors, Synchronous Motors, Stepper Motors, and Servo Motors. Motor driving and speed control circuits and their applications, motor starters.

Unit- 3 **(18 Lectures)**

Generators and AC machines: AC and DC generators, comparison between generator and motor action (without constructional comparison). AC Machines: Types of transformers, Transformer Construction, E.M.F. equation, Transformer Losses, Condition for maximum efficiency, all day efficiency, Auto transformers.

Unit- 4 **(10 Lectures)**

Supplies: Regulated power supply, Uninterrupted power supply (UPS) and Switched mode power supply (SMPS).

Suggested Books:

1. Power Electronics, 2nd Edition (2006), M. D. Singh, K. B.Khanchandani, Tata McGraw Hill.
2. Electrical Technology, 23rd Edition (2005), B. L. Thareja and A. K. Thareja, S. Chand & Sons.
3. Electronic Principles, 7th Edition (2007), A. Malvino, D. J. Bates, Tata McGraw Hill.
4. Power Electronics, 4th Edition (2002),P. S. Bimbhra, Khanna Publishers.
5. Electrical Machines, 2nd Edition (1997), I. J. Nagrath and D. P. Kothari, Tata McGraw Hill (1997).

Power Electronics Lab
(60 Lectures)

1. Study of I-V characteristics of SCR.
2. Study of I-V characteristics of DIAC.
3. Study of I-V characteristics of TRIAC.
4. Load characteristics of D.C. motor.
6. Speed control of D.C. motor.
7. Break test of D.C. motor.
8. Break test of induction motor.

Control Systems
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit- 1 **(16 Lectures)**

Introduction to Control System: Introduction of open loop and closed loop control systems, mathematical modelling of physical systems (Electrical, Mechanical and Thermal), derivation of transfer function, Armature controlled and field controlled DC servomotors, AC servomotors, block diagram representation & signal flow graph, Reduction Technique, Mason's Gain Formula. Effect of feedback on control systems, Basic Control Actions: Proportional, integral and Derivative controls

Unit- 2 **(16 Lectures)**

Time Domain Analysis: Time – Domain Analysis:-Time domain performance criteria, transient response of first, second & higher order systems, steady state errors and static error constants, performance indices, response with P, PI and PID Controllers. **Concept of Stability:** Asymptotic stability and conditional stability, Routh – Hurwitz criterion, relative stability analysis, Root Locus plots and their applications.

Unit-3 **(15 Lectures)**

Frequency Domain Analysis: Frequency Domain Analysis: Correlation between time and frequency response, Polar and inverse polar plots, frequency domain specifications, Logarithmic plots (Bode Plots), gain and phase margins, Nyquist stability criterion, relative stability using Nyquist criterion, constant M & N circles.

Unit-4 **(13 Lectures)**

Compensation Techniques & State Space Analysis
Compensation Techniques**:** Concept of compensation, Lag, Lead and Lag-Lead networks
State Space Analysis: Definitions of state, state variables, state space, representation of systems, Solution of time invariant, homogeneous state equation, state transition matrix and its properties.

Suggested books:

1. J. Nagrath & M. Gopal, Control System Engineering, New Age International, 2000, 2nd Edition
2. K. Ogata, Modern Control Engineering, PHI 2002, 4th Edition.
3. B. C. Kuo , "Automatic control system", Prentice Hall of India, 2000, 7th Edition
4. I. J. Nagrath& M. Gopal, Control System Engineering, New Age International, 2000, 2nd Edition
5. N.K Jain, Automatic Control System Engineering, Dhanpat Rai Publication,2005, 2nd Edition
6. B. S. Manke, Linear Control Systems, Khanna Publishers, Delhi, 7th Edition

Control Systems Lab
(60 Lectures)

1. To study characteristics of :
   a. Synchro transmitter receiver
   b. Synchro as an error detector
2. To study position control of DC motor
3. To study speed control of DC motor
4. To find characteristics of AC servo motor
5. To study time response of type 0,1 and 2 systems
6. To study frequency response of first and second order systems
7. To study time response characteristics of a second order system.
8. To study effect of damping factor on performance of second order system
9. To study frequency response of Lead and Lag networks.
10. Study of P, PI and PID controller.

Concepts of Chemistry
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit 1 **(19 Lectures)**

Periodic Table: Atomic, ionic and covalent radii, ionization energy, electro negativity and its scales, electron affinity, Lanthanide contraction, Inert pair effect, Slater rules.
Chemical bonds and molecules: Recapitulation of general characteristics of ionic & covalent bonds and shapes of molecules, Van der Waal forces of attraction (ion-dipole, dipole-dipole, dipole-induced dipole, and dispersion forces), polar covalent bond, hydrogen bond, effects of hydrogen bonding on physical properties, structure of water. metallic bond, lattice energy, Born Haber cycle, Fajan's rule, bond length, bond angle.
Acid and Bases: Bronsted-Lowry theory, concept of leveling and differentiating solvents. Lewis concept of acids and bases, Relative strength of lewis acids and bases and the effect of substituents.

Unit 2 **(19 Lectures)**

Organic reactions and their mechanisms, types of reactions -, Mechanism of SN1 and SN2 reactions (stereochemistry, nature of substrate, nucleophile and leaving group).Keto-enol tautomerism and its distinction from resonance. Structure and stability of reactive carbon species - carbonium ion, carbanion, free radical, carbenes. Electronic effects in molecules (inductive, hyperconjugation and resonance effects); cleavage of covalent bonds – homolysis and heterolysis. Electrophilic substitution in benzene. Reaction mechanisms of Aldol condensation, Hoffman bromamide rearrangement, Cannizzaro reaction, Friedel Craft reaction, Pinacolpinacolone rearrangement, Beckmann rearrangement.
Pharmaceuticals: Synthesis of aspirin, paracetamol, sulphanilamide, their uses and drug action.
Reagents for organic synthesis: Active methylene compounds - preparation, properties and synthetic applications of ethylacetoacetate and diethylmalonate, Grignard reagents – preparation and reactions.

Unit 3 **(12 Lectures)**

Stereochemistry: Optical activity and optical isomerism, specific molar rotation, asymmetric carbon atom, chirality, enantiomerism, relative configuration (sequence rules, R/S nomenclature of chiral centres), absolute configuration (D/L designation in carbohydrates), geometrical isomerism (cis/trans and E/Z nomenclature in olefins) isomers of lactic acid and tartaric acid
Aromaticity: Concept of aromaticity, Huckle's rule as applied to benzene, naphthalene, anthracene, phenenthrene, thiophene, furan, pyrrole, pyridine, quinolene and cyclic cations & anions.

Unit 4 **(10 Lectures)**

Chemical equilibrium: Reversible reactions, law of mass action, equilibrium constant, ionic equilibrium, theory of indicators, factors influencing equilibrium states, relation between Kp & Kc, buffer solution, hydrolysis of salt, pH, Ksp, common ion effect and its applications in mixture analysis**.**

Electrochemistry; Standard electrode potential, electrochemical series, Nernst equation, Indicator and reference electrodes, pH and its measurement by glass electrode. Potentiometric determination of pH

Suggested Books:

1. J. D. Lee, Concise Inorganic Chemistry, ELBS.
2. J.E. Huheey, Inorganic Chemistry – Principles of Structure and Reactivity, Pearson Publication.
3. I.L. Finar, Volume I, II, Organic Chemistry, ELBS.
4. R.T. Morrison and R.N. Boyd, Organic Chemistry, Prentice Hall.
5. G.M. Barrow, Physical Chemistry, Tata McGraw-Hill.
6. G.W. Castellan, Physical Chemistry, Narosa Publishing House.
7. J. March, Advanced Organic Chemistry, Prentice Hall
8. F.A. Cotton and G. Wilkinson, Basic Inorganic Chemistry, John Wiley.
9. E.S. Gilreath, Fundamental Concepts of Inorganic Chemistry
10. W.L. Jolly, Modern Inorganic Chemistry, Longman.

Concepts of Chemistry Lab
(60 Lectures)

1. To estimate iron (II) ions by titrating with potassium permanganate.
2. To determine melting points and boiling points of organic compounds.
3. To detect extra elements (N, S, Cl, Br, I) in organic compounds (containing not more than one extra element).
4. To analyze the following functional groups in the given organic compound: Carboxylic acids, alcohols, phenols, aldehydes & ketones, carbohydrates (monosaccharide's), amides, nitro compounds and primary amines.
5. To determine surface tension of a liquid using a stalagmometer.
6. To determine viscosity of a liquid using an Ostwald viscometer

Signals and Systems
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit 1 **(18 Lectures)**

Signals and Systems: Continuous and discrete time signals, Transformation of the independent variable, Exponential and sinusoidal signals, Impulse and Unit step functions, Continuous-Time and Discrete-Time Systems, Basic System Properties.

Unit 2 **(15 Lectures)**

Linear Time-Invariant Systems (LTI): Discrete time LTI systems, the Convolution Sum, Continuous time LTI systems, the Convolution integral, Properties of LTI systems, Commutative, Distributive, Associative.

Unit 3 **(15 Lectures)**

Properties of LTI System: LTI systems with and without memory, Invariability, Causality, Stability, Unit Step response, Differential and Difference equation formulation, Block diagram representation of first order systems.

Unit 4 **(12 Lectures)**

Laplace Transform: Laplace Transform, Inverse Laplace Transform, Properties of the Laplace Transform, Laplace Transform Pairs, Laplace Transform Methods in Circuit Analysis, Impulse and Step response of RL, RC and RLC circuits.

Suggested Books:

1. H. P. Hsu, Signals and Systems, Tata McGraw Hill(2007)
2. S. T. Karris, Signal and Systems: with MATLAB ,Computing and Simulink Modelling, Publications (2008)
3. W. Y. Young, Signals and Systems with MATLAB, Springer (2009)
4. M. Roberts, Fundamentals of Signals and Systems, Tata McGraw Hill (2007)

Signals and Systems Lab
(60 lectures)

1. Learning Scilab/MATLAB (Experiments based on available system)
2. Explorations of Signals and Systems using Scilab/MATLAB
   a. Generation of Signals: continuous time
   b. Generation of Signals: discrete time
   c. Convolution of Signals
   d. Solution of Difference equations.
   e. Introduction to SIMULINK and calculation of output of systems represented by block diagrams

Advanced Analytical Instrumentation

(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit 1 **(20 Lectures)**

Nuclear Magnetic Resonance (NMR) Spectroscopy : Theory, chemical shift and spin-spin splitting, coupling constant, environmental effects- shielding deshielding effects due to electronegativity on NMR spectra, instrumentation of NMR , FT-NMR and its advantages, applications.
Mass Spectroscopy: Theory, fragmentation modes, instrumentation: inlet systems, magnetic and electrostatic analysers, detectors. Isotopic abundances, metastable ions and applications.

Unit 2 **(15 Lectures)**

Electro Analytical Methods of Analysis: Potentiometry: Introduction, reference electrode, indicator electrodes, ion-selective electrodes and their applications, instrumentation, direct potentiometry, potentiometric titrations, applications

Unit 3 **(14 Lectures)**

Radiochemical methods: X-ray spectroscopy- Principle, absorption, emission and diffraction of X-rays, Bragg's Law, Instrumentation: sources, X –ray tube, crystal monochromators, X-ray detectors (Ionization, proportional and GM counter, γ camera), applications.

Unit 4 **(11 Lectures)**

Polarography: Basic principle, direct current polarography, different kinds of currents, reversible and irreversible waves, pulse and ac polarography, applications**.**
Automated Methods of Analysis: Types of automated systems, Flow Injection Analysis, Microfluidics, Discrete automatic system.

Suggested Books:

1. Skoog & Lerry, Instrumental Methods of Analysis, Saunders College Publications, New York
2. H.H.Willard, Instrumental Methods of Analysis, CBS Publishers.
3. D.C. Harris, Quantitative Chemical Analysis, W.H.Freeman
4. Gary D. Christian, Analytical Chemistry, John & Sons, Singapore
5. Skoog, West and Holler, Analytical Chemistry, Saunders College Publications, New York
6. Vogel's Textbook of Qualitative Chemical Analysis, ELBS
7. J.A. Dean, Analytical Chemistry Notebook, McGraw Hill
8. John H. Kennedy, Analytical Chemistry: Principles, Saunders College Publication
9. W. Kemp, Organic Spectroscopy, ELBS
10. Frank Settle, editor, Hand book of Instrumental Techniques for Analytical Chemistry, Prentice Hall.
11. Galen W. Ewing, Instrumental Methods of Chemical Analysis, McGraw-Hill Book Company

Advanced Analytical Instrumentation Lab

(60 Lectures)

1. Quantitative Analysis of organic compounds using Gas chromatography
2. Quantitative Analysis of organic compounds using HPLC.
3. Study of NMR (Simulation based/Demo).
4. Study of Mass spectrometer (Simulation based/Demo).
5. Study of X ray spectrometer (Simulation based/Demo).
6. Potentiometric titrations: (i) Strong acid with strong base (ii) weak acid with strong base and (iii) dibasic acid with strong base
7. Potentiometric titration of Mohr's salt with potassium dichromate
8. pH metric titrations of (i) strong acid and strong base (ii) weak acid and strong base
9. Group Projects based on analytical techniques.

Communication systems
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit 1 **(7 Lectures)**

Basic communication system: Block diagram, Information source and input transducer, Transmitter medium, Noise, Receiver, Destination, Necessity for modulation, Types of communication systems.

Unit 2 (**18 Lectures)**

Amplitude Modulation, Frequency and phase modulation: Definition - AM waveforms - Frequency spectrum and hand width - Modulation index - DSB - SC, SSB, Independent SB, Vestigial SB - Comparison and application of various AM schemes, Definition-Relationship between FM & PM - Frequency deviation - Spectrum and transmission BW of FM, comparison of AM and FM systems.

Unit 3 (**16 Lectures)**

Radio Transmitter and Receiver: AM transmitters-High level and low level transmitters - SSB transmitters - FM transmitters - Block diagram - stereo FM transmitter.
AM receivers-operation - performance parameters - Communication Transceivers - Block diagram - SSB receiver - FM receivers - Block diagram.

Unit 4 **(19 Lectures)**

Digital Communication: Pulse Analog Modulation**:** Sampling theorem, Errors in Sampling. Pulse Amplitude Modulation (PAM), Time Division Multiplexing (TDM). Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM). Generation and detection of PAM, PWM, PPM,
PCM- Need for digital transmission, Quantizing, Uniform and Non-uniform.
Quantization, Quantization Noise, Companding, Coding, Digital Formats. Decoding, Regeneration, Transmission noise and Bit Error Rate

Suggested Books:

1. G. Kennedy and B. Davis, Electronic Communication Systems, Tata McGraw Hill (1999)
2. R. P. Singh and S. D. Sapre, Communication Systems: Analog and Digital, Tata McGraw Hill (2007)
3. L. E. Frenzel, Communication Electronics: Principles and Applications, Tata McGraw Hill (2002)
4. L. W. Couch II, Digital and Analog Communication Systems, Pearson Education (2005)
5. T. G. Thomas and S. Chandra Sekhar, Communication Theory, Tata McGraw Hill (2006)
6. L. Temes and M. E. Schultz, Schaum's outline of theory and problems of Electronic Communication (1997)
7. H. Taub and D. Schilling, Principles of Communication Systems, Tata McGraw Hill (1999)
8. W. Tomasi, Electronic Communication Systems: Fundamentals through Advanced, Pearson Education (2004)
9. L. E. Frenzel, Communication Electronics, Principles and Applications, Tata McGraw Hill (2002)
10. L. W. Couch II, Digital and Analog Communication Systems, Pearson Education (2005)

11. H. P. Hsu, Analog and Digital Communications, Tata McGraw Hill (2006)
12. S. Haykin, Communication Systems, Wiley India (2006)

Communication Systems Lab

(60 Lectures)

1. Study of Amplitude Modulation and Demodulation
2. Study of Frequency Modulation and Demodulation
3. Study of Single Side Band Modulation and Demodulation
4. Study of AM Transmitter and Receiver
5. Study FM Transmitter and Receiver
6. Study of Pulse Amplitude Modulation
7. Study of Pulse Width Modulation
8. Study of Pulse Position Modulation
9. Study of Pulse Code Modulation

Advanced Biomedical Instrumentation

(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit 1 **(15 Lectures)**

Anaesthesia Machine: Need of anesthesia, anesthesia delivery system, breathing circuits.
Clinical Laboratory Instruments: General principle and working of Blood Gases Analyzer, Auto-analyzer, Blood Cell Counters, ELISA reader, spectrophotometer, flame photometer.

Unit 2 **(17 Lectures)**

Medical Imaging System: Ultrasound, properties, its generation & detection, types of transducers, diagnostic application – A Scan, B Scan, M Scan, real time ultrasonic imaging, linear array scanners, X-ray computed tomography (CT Scanner) and computer-aided tomography (CAT)-principle, contrast scale, scanning system, processing Unit, viewing, storage.
Magnetic Resonance Imaging: Basic principle, working and construction.

Unit 3 **(15 Lectures)**

Nuclear Medicine System: radioactive emissions, rectilinear scanner, gamma camera, imaging system, ECT (emission coupled tomography), positron emission tomography (PET), Single-photon emission computed tomography (SPECT), safety measures.

Unit 4 **(13 Lectures)**

Surgical Scopy and Diathermy Equipments: Fibre Optics- Endoscopes -light sources, video processors, camera, and fiber optic cable, Principles and applications.
Diathermy: Infrared radiation (IR) diathermy, ultraviolet (UV) diathermy, short wave diathermy, microwave diathermy, ultrasonic diathermy, Surgical Diathermy.

Suggested Books:

1. Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Fourth edition, Pearson Education Inc (2010), 2nd edition
2. Khandpur R.S., Handbook of Biomedical Instrumentation, Second edition, Tata McGraw-Hill Publishing (2009), 2nd edition
3. Joseph D. Bronzino, The Biomedical Engineering Handbook, IEEE Press (2000), 2nd edition, Volume 1.
4. Richard Aston, Principles of Biomedical Instrumentation & Measurement, Merrill Publishing Company, (1990), 1st edition
5. Mandeep Singh, Introduction to Biomedical Instrumentation, PHI learning private limited (2010), 1st edition.
6. Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Second edition, Prentice Hall (2010), 2nd Edition.

Advanced Biomedical Instrumentation Lab

(60 Lectures)

1. Study of ultrasound transducers based on medical system.
2. Differentiating arteries and veins using ultrasound transducers.
3. Measurement of respiration rate using thermistor /other electrodes.
4. Measurement of pulse rate using photoelectric transducer & pulse counting for known period.
5. Study of X ray/CT machine (through demonstration).
6. Study of nuclear imaging techniques (through demonstration).
7. Study of mammograms and CT scan images.
8. Analysis of blood sample using Auto-analyzer
9. To check blood gases using blood gas analyzer
10. To estimate different parameters of blood using blood cell counter.
11. Estimation of serum total protein using spectrometer.
12. Estimation of sodium and potassium in blood serum or urine sample.

Embedded System and Robotics

(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit 1 **(18 Lectures)**

Introduction to RISC microcontrollers: Von- Neumann and Harvard architectures, Introduction to 8051 family microcontrollers, 8051 architecture, Register banks and Special Function Registers**,** Block Diagram, Addressing Modes, Instruction Set, Timers, Counters, Stack Operation, Programming using PIC microcontroller.

Unit 2 **(14 Lectures)**

Introduction to Embedded Systems: Overview of Embedded Systems, Features, Requirements and Applications of Embedded Systems, Recent Trends in the Embedded System Design, Common architectures for the ES design, Embedded Software design issues, Communication Software, Introduction to Development and Testing Tools

Unit 3 **(16 Lectures)**

8051 Interfacing: 8051 interfacing with Keyboard, display Units (LED, 7-segment display, LCD), ADC, DAC, Stepper motor, Introduction to AVR family and its architecture.
Interfacing and Communication Links Serial Interfacing: SPI / Micro wire Bus, I2C Bus, CAN Bus

Unit 4 **(12 Lectures)**

Robotics: Overview of Robotics, Pattern recognition and robots, Use of Embedded Systems in Robotics, Robots and Computer Vision

Suggested Books

1. Fundamentals of Embedded Software – where C and Assembly Meet by Daniel W. Lewis (Pearson Education).
2. Design with PIC Microcontrollers by John B. Peatman (Pearson Education).
3. Embedded C Programming and the Microchip PIC by Richard Barnett, Larry O'Cull and Sarah Cox (Thomson Learning).
4. Microprocessors: From Assembly Language to C using PIC18Fxx2 by Robert B. Reese (Shroff Publishers and Distributors Pvt Ltd)
5. Robotic Engineering – An Integrated Approach by Richard D Klafter, Thomas A. Chmielewski and Michael Negin (PHI).
6. Muhammad Ali Mazidi, Janice Gillispie Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson education Asia, New Delhi (1999), 2nd Edition.

Embedded System and Robotics Lab(Using 8051 or any other microcontroller**)**
(60 Lectures)

1. Write a program to multiply two 16 bit unsigned numbers.
2. Write a program to add N 8 bit unsigned integer numbers.
3. Write a program to arrange the unsigned integer numbers in ascending/descending order.
4. Interface a display to the micro controller and display number sequentially in a regular interval.
5. Write a program for LED blinking in a predetermined fashion using 8051 * and PIC microcontrollers.
6. Write a Program to OUT an 8 – bit value on a 8051 and PIC microcontrollers.
7. Write a program for a simple counter, where the count has to be displayed on a 7 – segment LED display.
8. Write a program for interfacing LCD display using 8051 and PIC microcontrollers.
9. Write a program to convert an analog voltage to digital bits using 8051 and PIC microcontrollers
10. Write a program to convert a digital signal to analog signal using 8051 and PIC microcontrollers
11. Write a program for temperature sensor interfacing through serial port on 8051 and PIC microcontroller kits.
12. Write a program for P W M control of DC motor using 8051 and PIC microcontrollers.
13. Write a program to drive a stepper motor using 8051 and PIC microcontrollers.

Process Control Dynamics
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit 1 **(18 Lectures)**

Introduction: Dynamics of Processes, Dead time processes. Inverse response behavior of processes. Dynamic Behavior of first and second order systems. Interacting and non-interacting Systems. Batch & Continuous Process, concept of self-regulation, Controller Principle, discontinuous, continuous and composite controller modes/actions (P, I, D, PI, PD and PID). Pneumatic, Hydraulic, Electronic controllers. Need for controller tuning, Evaluation criteria, Types of controller tuning

Unit 2 **(17 Lectures)**

Controls: Cascade control, Selective control, Ratio Control, Split range control, feed forward control, Feed forward combined with feedback control, Inferential Control, dead time and inverse response compensators, selective control, Adaptive control, Examples from Distillation columns, Chemical Reactors, Heat Exchangers and Boiler, Multivariable Control, Interaction, Tuning of Multivariable systems, relative gain analysis, Decoupler design.

Unit 3 **(15 Lectures)**

Discrete-State process control: Variables, process specification and event sequence description, Sampling and reconstruction, Transform analysis of sampled-data systems: z transform and its evaluation, inverse z transform, pulse transfer function, stability analysis in z-plane, implementation of digital controller. PLC Block Diagram, Scan cycle, memory organization, addressing, programming. Introduction to distributed control systems (DCS)

Unit 4 **(10 Lectures)**

Converters and Actuators: I/P, P/I converters, Final control elements, Pneumatic and electric actuators. Types of control valves, Valve positioner and its importance, Inherent and Installed characteristics of control valves.

Suggested Books:

1. Eckman. D.P, Automatic Process Control, Wiley Eastern Ltd., New Delhi, 1993, Original Edition
2. Johnson C.D., Process Control Instrument Technology, Prentice Hall Inc. 1988, 7th Edition
3. Bequette B. W. , Process Control Modelling, Design and Simulation, PHI Learning, Original Edition
4. Ogata K., Discrete Time Control Systems, Pearson Education, 2nd Edition
5. Kuo B. C. , "Automatic control system", Prentice Hall of India, 2000, 7th Edition
6. Nagrath I. J. and Gopal M., Control System Engineering, New Age International,2000, 2nd Edition
7. Stephanopoulis G., Chemical Process Control, Prentice Hall of India, New Delhi, 1990, Original Edition
8. Liptak B.G., Instrument Engineers Handbook, Process Control, Chilton Book Company, 3rd Edition
9. Harriott P., Process Control, Tata McGraw Hill, Edition 1972.
10. Anderson N.A., Instrumentation for Process Measurement and Control, Chilton company 1980, 3rd Edition
11. Pollard A., Process Control, Heinemann educational books, London, 1971, Original Edition

12. Smith C.L. and Corripio A. B., Principles and Practice of Automatic Process Control, , John Wiley and Sons, New York, 2nd Edition
13. Shinskey, Process Control Systems, McGraw Hill, Singapore, 1996, 4th Edition.

Process Control Dynamics lab

(60 Lectures)

1. Study of PID controller response and it's tuning
2. Study of ON-OFF and Proportional controller responses on temperature loop.
3. Analysis of Flow loop/Level loop/Temperature loop/Pressure loop.
4. Tuning of controllers on a pressure loop.
5. Control valve characteristics with and without positioner.
6. Study of cascade control
7. Study of ratio control/selective control
8. Study of feed forward control
9. Study of pneumatic/ hydraulic controllers
10. Problem solving/Ladder Programming in PLC.
11. Mathematical modeling and simulation of CSTR & STH systems

Reliability and Quality Control Techniques
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit 1 **(15 Lectures)**

Quality Concepts: Meaning of Quality, Approaches- Deming's Approach, Juran's Approach, Quality of Product, Quality of Service, Cost of Quality, Value of Quality, Difference between Inspection, Quality Control and Quality Assurance, Evaluation of Quality control, Quality Improvement Techniques Pareto Diagrams, Cause-Effect Diagrams Quality Circles, Kaizen, six sigma.

Unit 2 **(17 Lectures)**

Control Charts: Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, ARL, sensitizing rules for control charts, Control Charts for X-bar& R (statistical basis, development and use, estimating process capability; interpretation, the effect of non-normality on the chart, the OC function, average run length and control chart for attribute (p, np, c)

Unit 3 **(15 Lectures)**

Acceptance Sampling: Meaning, objective, and types of research, approaches, Principle of acceptance sampling, Producer's and consumer's risk. AOQL and LTPD, Sampling plans –single, double, O C curve

Unit 4 **(13 Lectures)**

Reliability: Different types and modes of failure, causes of failure in electronic components, reliability theory, hazard rate, failure density function, availability, maintainability, mean time to failure and repair system structures: series, parallel, K-type, reliability evaluation, optional reliability and redundancy allocation, Fault tree analysis

Suggested Books:

1. D. C. Montgomery , Introduction to Statistical Quality Control, John Wiley and sons, 4th edition.
2. Reliability Engineering by S.Shreenath, 4th Edition, East West Press

Reliability and Quality Control Techniques Lab
(60 Lectures)
Use latest statistical software package like SPSS

1. Descriptive statistics
2. Control charts for variable
3. Control charts for attribute
4. OC curve
5. Single sampling and double sampling
6. AOQ curve

Programming in C
(Credits: 02)

Total Lectures: 60

Unit 1 **(14 Lectures)**

Introduction: Algorithm / pseudo code, flowchart, program development steps, structure of C program, identifiers, basic data types and sizes, Constants, variables, Operators, expressions, Input-output statements, if and switch statements, loops- while, do-while and for statements, break, continue, goto and labels.

Unit 2 **(11 Lectures)**

Functions: Parameter passing, storage Lectures- extern, auto, register, static, scope rules, block structure, user defined functions, standard library functions, recursive functions, header files, C preprocessor, example C programs.

Unit 3 **(17 Lectures)**

Arrays and pointers: Arrays concept, declaration, accessing elements, storing elements, arrays and functions, two dimensional and multi-dimensional arrays, applications of arrays. pointers- concepts, initialization of pointer variables, pointers and function arguments, address arithmetic, Character pointers and functions, pointers to pointers, pointers and multidimensional arrays, dynamic memory managements functions, command line arguments, C program examples.

Unit 4 **(18 Lectures)**

Derived types: Structures declaration, Initialization, accessing structures, nested structures, arrays of structures, structures and functions, pointers to structures, self-referential structures, unions, type def, bitfields, C program examples. Input and output - concept of a file, streams, standard I/o, Formatted I/O, file I/O operations, error handling, C program examples.
Searching and sorting: Searching - Linear and binary search methods, sorting - Bubble sort, selection sort, Insertion sort.

Suggested Books

1. Behrouz A. Forouzan and Richard F. Gilberg, Computer science - A structured programming approach using C, Third edition, Cengage Learning.
2. Byron S. Gottfried, Programming with C, 2nd Edition, McGraw-Hill Publishing
3. E Balagurusamy, Programming in ANSI C, 4th Edition, Tata McGraw-Hill Publishing
4. P. Padmanabham, C & Data structures, B.S. Publications.
5. B.W. Kernighan, Dennis M.Ritchie, The C Programming Language, Pearson Education
6. J.A. Jones & K. Harrow, C Programming with problem solving, Dreamtech Press
7. Stephen G. Kochan, Programming in C, III Edition, Pearson Education.

VLSI Design and Verification
(Credits: 02)

Total Lectures: 60

Unit 1 **(19 Lectures)**

MOS Technology and Circuits: MOS Technology and VLSI, Process parameters and considerations for BJT, MOS and CMOS, Electrical properties of MOS circuits and Device modeling, MOS Circuit Design Process, MOS Layers, Stick diagram, Layout diagram, Propagation delays, Examples of combinational logic design, Sealing of MOS circuits.

Unit 2 **(08 Lectures)**

Analog VLSI and High speed VLSI: Introduction to Analog VLSI, Realization of Neutral Networks and Switched capacitor filters, Sub-micron technology and GaAs VLSI technology

Unit 3 **(14 Lectures)**

Hardware Description Languages: VHDL background and basic concepts, structural specifications of hardware design organization and parameterization.

Unit 4 **(19 Lectures)**

VLSI Verilog: Introduction, gate level modeling, modeling and concept of wire, creation, module instantiation, ports and their mapping , data flow modeling, various operators, Verilog language and data types, modeling delays-specparam, behavioral modeling.
Simulation - Gate-level modeling and simulation, Switch-level modeling and simulation, Combinational Logic Synthesis, Binary Decision Diagrams, Two Level Logic Synthesis.

Suggested Books

1. Douglas A. Pucknell and Kamran Eshraghian, Basic VLSI Design Systems and Circuits, Prentice Hall of India Pvt.Ltd.
2. Wayne Wolf, Modern VLSI Design, 2 Edition, Prentice Hall.
3. Amar Mukherjee, Introduction to NMOS and CMOS VLSI System Design, Prentice Hall.
4. Randall L Geiger and PE Allen, VLSI Design Techniques for Analog and Digital Circuits, McGraw Hill International Company.
5. Fabricious.E, Introduction to VLSI Design, McGraw Hill.
6. Navabi.Z, VHDL Analysis and Modeling of Digital Systems, McGraw Hill.
7. Mohammed Ismail and Terri Fiez, Analog VLSI Signal and Information Processing, McGraw Hill.
8. Peter J Ashenden, the Designer's Guide to VHDL, Harcourt Asia Private Limited & Morgan Kauffman.

Testing and Calibration
(Credits: 02)

Total Lectures: 60

Unit 1 **(18 Lectures)**

Calibration and Standardization Practices Units: Fundamental and Derived Units, Standards: Primary, Secondary and Tertiary standards, Standardizations and Technique: Standardizations of Electrical (voltage, current, frequency, RLC and others), Mechanical (mass, displacement, velocity, acceleration, torque, flow, level, temperature, pressure etc.) and other parameters.

Unit 2 **(18 Lectures)**

Advanced measurement and Calibration equipment: Inductive voltage dividers, AC and DC comparators, Programmable synthetic signal sources and power supplies, Quad bridge, Automatic AC bridges, Phase sensitive detectors, Lock-in-amplifiers, Digital phase and frequency measurements

Unit 3 **(12 Lectures)**

Standardization and calibration modeling: Standardization in Production Plants and manufacturing houses, Reliability studies and inspection, Product Standardization techniques, Calibration: Calibration of measuring Instruments, Theory and Principles (absolute and secondary or comparison method), Setup, Modeling.

Unit 4 **(12 Lectures)**

Various testing and calibration systems: Sensor calibration and testing, Analytical methods in calibrating. Automated test and calibration systems: GPIB based systems, machine computation of errors and uncertainties in measurement

Suggested Books

1. Patrick O'Connor, Test Engineering: A Concise Guide to Cost-effective Design, Development and Manufacture (Quality and Reliability Engineering Series), Wiley-Blackwell.
2. Keith R. Cheatle, 2006, Fundamentals of Test Measurement Instrumentation, Illustrated Ed., ISA
3. B.G. Liptak 2003, Instrument Engineers Handbook - Process Measurement and Analysis, volume 1, 4th Ed., ISA.
4. Alan S. Morris, 2003, Measurement and Instrumentation Principles, 1st Ed., Butterworth-Heinemann.
5. N. E. Battikha, 2007, The Condensed Handbook of Measurement and Control, 3rd Ed., ISA

PLC and SCADA
(Credits: 02)

Total Lectures: 60

Unit 1 **(12 Lectures)**

Single loop control, Centralized control, Distributed control systems, Open systems, SCADA systems, Types of data available, Data communication components and protocols.

Unit 2 **(18 Lectures)**

Programmable Logic Controllers (PLC), input/output systems, CPU, memory Unit, Programmer Units, Peripheral devices, Controller programming tools, Programming of PLCs, PLC Hardware Environment.

Unit 3 **(10 Lectures)**

Distributed Control Systems (DCS), PLC vs. DCS systems, Local control Units, dedicated card controllers, Unit Operations controllers, DCS multiplexers, DCS system integration.

Unit 4 **(20 Lectures)**

Supervisory Control and Data acquisition (SCADA) Systems, Types of supervisory systems, Distributed Digital Control Systems (DCS), Direct digital control (DDC), SCADA: Components of SCADA Systems, field data interface devices, communication network and other details, System Architecture: monolithic, distributed, networked, SCADA protocols in short, application of SCADA in industry; installation of SCADA Systems; security and weakness of SCADA Systems.

Suggested Books

1. S. Gupta, JP Gupta, “PC interface For Data Acquiring & Process Control”, 2nd Ed., Instrument Society of America.
2. John W. Web, Ronald A. Reis, “Programmable Logic Controllers” 5th Edition, PHI
3. Liptak, B. G. (E.d.), “Instrument Engineers Handbook”, vol. I to III, Chilton Book Co.
4. Bhatkar, Marshal, “Distributed Computer control & Industrial Automation”, Dekker Publication
5. Frank D. Petruzella, “Programmable Logic Controllers”, 3rd Edition, McGraw Hill

Virtual Instrumentation
(Credits: 02)

Total Lectures: 60

Unit 1 **(08 Lectures)**

Introduction to Virtual Instrumentation: The LabVIEW Programming Environment: Controls/ Indicators, Auto indexing, Debugging, Timing issues (counters), Importing pictures, Simple programming structures and Timing Issues, Basic operations, controls and indicators.

Unit 2 **(18 Lectures)**

Programming Techniques: VIS and sub-VIS, Debugging a VI and Sub-VI's, loops & charts, arrays, clusters, graphs, case & sequence structures, formula modes, local and global variable, string & file input, Graphical programming in data flow.

Unit 3 **(18 Lectures}**

Data Acquisition Basics: ADC, DAC, DIO, Counters & timers, PC Hardware structure, timing, interrupts, DMA, Software and Hardware Installation. GPIB/IEEE 608 concepts, and embedded system buses - PCI, EISA, CPCI, and USB& VXI.

Unit 4 **(16 Lectures)**

Use of Analysis Tools: Fourier transforms, Power spectrum, Correlation methods, Windowing & flittering.
Developing applications on LabVIEW: Process control, Waveform generator, Motion control using stepper motor, Image acquisition, Temperature data acquisition system, Processing using programming structure.

Suggested Books

1. John Essick , Hands on Introduction to LabVIEW for Scientists and Engineers, 1st Edition
2. S. Gupta, J.P. Gupta, PC Interfacing for Data Acquisition and Process Control, ISA, 2nd Edition
3. Gary Johnson, LABVIEW Graphical Programming, McGraw Hill, 2nd Edition.
4. Lisa K. Wells and Jeffrey Travis, LABVIEW for Everyone, PHI.
5. Skolkoff, Basic concepts of LABVIEW 4, PHI.
6. James K, PC interfacing and data acquisition.
7. Technical Manuals for DAS Modules of Advantech and National Instruments. L.T. Amy, Automation System for Control and Data Acquisition, ISA.

Programming using MATLAB
(Credits: 02)

Total Lectures: 60

Unit 1 **(15 Lectures)**

Introduction to MATLAB: Features, MATLAB Windows(Editor, Work Space, Command History, Command Window),Operations with Variables, Naming and Checking Existence, Clearing Operations, Introduction to Arrays, File Types

Data and Data Flow in MATLAB: Matrix Operations & Operators, Reshaping Matrices, Importing Exporting of Data, Arrays, Data types, File Input-Output, Communication with External Devices

Unit 2 **(15 Lectures)**

Editing and Debugging M Files: Writing Script Files, Writing Functions, Error Correction, M-Lint Automatic Code Analyzer, Saving Files

Programming: Flow Control, Conditional Statements, Error Handling, Work with Multidimensional Array, Cell Array & Characters, Developing User Defined Function, Scripts and Other Functions

Unit 3 **(08 Lectures)**

MATLAB Graphics: Simple Graphics, Graphic Types, Plotting Functions, Creating Plot & Editing Plot (2DGraphics Handles, GUI (Graphical User Interface)

Unit 4 **(22 Lectures)**

Digital Signal Processing: To study about the basic application of DSP, write program for modulation and Demodulation, write program for time scaling and amplitude Scaling, Generate various functions and implement on image.

Image Processing: To study about the basic image processing tools, write program for Histogram processing, Write program for image segmentation, Write program image restoration.

Suggested Books

1. Fausett, L. V., Applied Numerical Analysis Using MATLAB, Prentice Hall, Upper Saddle River, New Jersey.
2. Mathews, J.H. and K.D. Fink, Numerical Methods Using MATLAB - Third Edition, Prentice Hall, Upper Saddle River, New Jersey
3. Linfield, G. & Penny, J., Numerical methods using MATLAB, Ellis- Horwood.
4. Van Loan, C.F., Introduction to Scientific Computing - A Matrix-Vector Approach Using MATLAB, Prentice Hall, Upper Saddle River, New Jersey
5. Nakamura, S., Numerical Analysis and Graphic Visualization with MATLAB - Second Edition, Prentice Hall PTR, Upper Saddle River, New Jersey

Sensors and Actuators
(Credits: Theory-04, Practicals-02)

Total Lectures: 60

Unit 1 **(22 Lectures)**

Classification of transducers: Active, Passive, Mechanical, Electrical and their comparison. Selection of Transducers, Principle and working of following types: Displacement transducers - Resistive (Potentiometric, Strain Gauges – Types, Gauge Factor, Semi-conductor strain gauge) Capacitive, Inductive (LVDT-Principle and characteristics, Piezoelectric, light (photo-conductive, photo emissive, photo voltaic, semiconductor, LDR), Temperature (electrical and non-electrical), load cell

Unit 2 **(13 Lectures)**

Flow meters, mechanical type -Theory of variable head type flow meters – orifice plate, venture tube, flow nozzle, Positive displacement flow meters

Unit 3 **(11 Lectures)**

Rota meter: thermal mass flow meter, Principle and constructional details of electromagnetic flow meter, different types of ultrasonic flow meters

Unit 4 **(14 Lectures)**

Tachometers, Mechanical, Electric, Contact less, Frequency, Stroboscopic tachometers. Elementary accelerometers, Manometers – different types – elastic type pressure gauges – Bourdon type bellows – diaphragms –measurement of vacuum

Suggested Books:

1. A.K Sawhney, A course in mechanical measurements and instrumentation, Dhanpat Rai & Co, 12th edition
2. R.K. Jain, Mechanical and Industrial Measurements, Tata McGraw Hill, New Delhi, 1996, 11th edition.
3. A.K. Sawhney , Electrical & Electronic Measurements & Instrumentation, 19th revised edition
4. Nakra & Choudhary ,Instrumentation measurements and analysis , Tata McGraw Hill, 2nd edition

Sensors and Actuators Lab
(60 lectures)

1. Measurement of pressure, strain and torque using strain gauge.
2. Measurement of displacement using LVDT.
3. Measurement using load cells.
4. Measurement using capacitive transducer.
5. Measurement using inductive transducer.
6. Measurement of Temperature using Temperature Sensors/RTD.
7. Characteristics of Hall effect sensor.
8. Measuring change in resistance using LDR
9. Discharge coefficient of orifice plate.
10. Calibration of RTD.
11. E.M. flow meter.
12. Ultrasonic flow meter.

Electro-Mechanical Instruments
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit 1 **(07 Lectures)**

Measurement systems- static (accuracy, sensitivity, linearity, precision, resolution, threshold, range, hysteresis, dead band, backlash, drift), impedance matching and loading, dynamic characteristics (types, fidelity, speed of response, dynamic error).

Unit 2 (**22 Lectures)**

Types of motors and Motor Drives: Constructional features and characteristics of DC Motors, AC Motors, Induction Motors, Single and three phase Motors, Synchronous Motors, Stepper Motors, and Servo Motors. Motor driving and speed control circuits and their applications, motor starters.

Unit 3 (**18 Lectures)**

Measurement of vacuum -McLeod gauge, Pirani and Ionization Gauge– thermal conductivity gauges – Ionization gauge cold cathode and hot cathode types, Hot plate, Weighing balance: Analytical balance, Equal arm balance. Vacuum pumps, Concept of pumping speed, Rotary and Diffusion types.

Unit 4 (**13 Lectures)**

Refrigerants, Compressor, Evaporator, Condenser, Expansion Valves and their types. Centrifuge: Analytical centrifugation, Density Gradient Centrifugation, Microwave oven, Autoclave.

Suggested Books:

1. Nakra & Choudhary, Instrumentation Measurements and Analysis , Tata McGraw-Hill, 2nd edition
2. B. L. Thareja and A. K. Thareja, Electrical Technology, S. Chand & Sons, 23rd Ed.,
3. A. K. Sawhney, A course in mechanical measurements and instrumentation, Dhanpat Rai &Co., 12th Edition
4. R. S. Khurmi and J. K. Gupta, Text book of Refrigeration and Air conditioning, S. Chand Publication, 3rd Edition,
5. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry
6. Cambridge University Press, , 5th Edition
7. D.S Mathur, Mechanics, S.Chand and Company Ltd., 5th Edition.
8. R. Paul Singh and Dennis R. Heldman, Introduction to Food Engineering, Elsevier Academic Press, 4th Edition

Electro-Mechanical Instruments lab
(60 Lectures)

1. Power measurement in single & three phase circuit.
2. Load characteristics of D.C. motor.
3. Speed control of D.C. motor.
4. Break test of D.C. motor.
5. Break test of induction motor.
6. Study the stepper motor.
7. Study the induction motor starter.
8. Study the calibration of pressure gauges using dead weight tester.

Instrumentation & Control
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit 1 **(15 Lectures)**

Basic concepts of instrumentation block diagram representation. Open loop and closed loop control systems, mathematical modeling of physical systems, transfer function, Armature controlled and field controlled DC servomotors, AC servomotors, block diagram representation & signal flow graph, Reduction Technique, Mason's Gain Formula.Effect of feedback on control systems.

Unit 2 **(15 Lectures)**

Time – Domain Analysis:-Time domain performance criteria, transient response of first, second & higher order systems, steady state errors and static error constants, performance indices, response with P, PI and PID Controllers. **Concept of Stability:** Asymptotic stability and conditional stability, Routh – Hurwitz criterion, relative stability analysis, Root Locus plots and their applications.

Unit 3 **(15 Lectures)**

Frequency Domain Analysis: Correlation between time and frequency response, Polar and inverse polar plots, frequency domain specifications, Logarithmic plots (Bode Plots), gain and phase margins, Nyquist stability criterion, relative stability using Nyquist criterion, constant M & N circles, Design of Compensators

Unit 4 **(15 Lectures)**

Controller Hardware: Electronic pneumatic and hydraulic controller's implementation, single and composite modes of controllers. **Final Control Elements:** Control valves, types, actuators, Solenoid, I/P P/I converters, stepper motors.

Suggested Books:

1. K. Ogata, Modern Control Engineering, PHI 2002, 4th Edition
2. B. C. Kuo, "Automatic control system", Prentice Hall of India, 2000, 7th Edition
3. I. J. Nagrath& M. Gopal, Control System Engineering, New Age International, 2000, 2nd Edition
4. Nakra & Choudhary, Instrumentation Measurements and Analysis, Tata McGraw-Hill, 2nd Edition
5. Johnson .C.D., Process Control Instrument Technology, Prentice Hall Inc, 7th Edition

Instrumentation and Control Lab
(60 Lectures)

Some of the experiments mentioned above can be simulated on software (MATLAB/MathCAD/LabVIEW)

1. To study position control of DC motor
2. To study speed control of DC motor
3. To find characteristics of AC servo motor
4. To study time response of first and second order systems
5. To study frequency response of first and second order systems
6. To study effect of damping factor on performance of second order system
7. To study frequency response of Lead and Lag networks.
8. To Study of P, PI and PID controller
9. To study characteristics of
   a. Synchro transmitter receiver
   b. Synchro as an error detector

Analytical Instrumentation
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit 1 (**18 Lectures)**

Molecular Spectroscopy: Ultraviolet-Visible (UV-Vis) spectroscopy: principle, instrumentation and applications. Infra-Red spectroscopy: principle, instrumentation and applications

Unit 2 (**13 Lectures)**

Atomic spectroscopy: Theory, instrumentation and application of flame photometry and atomic absorption spectroscopy.

Unit 3 (**18 Lectures)**

Planar chromatography: Theory and application of paper and thin layer chromatography, Column chromatography: Principle, instrumentation and application of Gas Liquid Chromatography and High Performance Liquid Chromatography

Unit 4 (**11 Lectures)**

Potentiometry, Introduction, reference and indicator electrodes, ion selective electrodes and their applications.

Suggested Books:

1. Skoog, Holler and Crouch, Instrumental Analysis,, Cengage Learning, India edition, 2007
2. Skoog & Lerry, Instrumental Methods of Analysis, Saunders College Publications, New York, 4th edition,
3. H.H.Willard et al., Instumental Methods of Analysis, CBS Publishers, 7th edition
4. Jeffery G.H. et al., Vogel's Text of Quantitative Chemical Analysis, , Longman Scientific and Technical, New York, 5th edition .

Analytical Instrumentation Lab
(60 Lectures)

1. Determination of pKa value for bromophenol blue using double beam spectrophotometer.
2. Spectrometric determination of iron using double beam spectrophotometer.
3. Determination of concentration of sodium, calcium, lithium and potassium in sample using flame photometer.
4. Thin layer chromatographic(TLC) separation of samples from different origin (Biological/pharmaceutical/food)
5. Spectrum analysis using FT-IR.
    a. Qualitative analysis
    b. Quantitative analysis
6. Qualitative and quantitative analysis of various compounds using atomic absorption Spectroscopy.
7 Qualitative and quantitative analysis of organic compounds using Gas chromatography.8

8. Qualitative and quantitative analysis of organic compounds using HPLC.

Nuclear & Biomedical Instrumentation

(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit 1 **(07 Lectures)**

Introduction to bioelectric potential, bio-amplifier, components of man Instrument system, design factors of biomedical instruments, types of biopotential electrodes.

Unit 2 (**21 Lectures)**

Cardiac vascular system: Origin of (Electrocardiography) ECG signals, Instruments of ECG, bipolar system lead system I, II, III, Eithoven triangle, Augmented lead system, unipolar chest lead system, types of display.
Respiratory system: Types of volume, types of measurements, Instrumentations of respiratory system, pneumograph, principle & types of pneumograph, Spirometer, ventilators, heart lung machine,
Nervous system: Action potential of brain, brain wave, Instrumentation – Electro encephalography (EEG), analysis

Unit 3 **(20 Lectures)**

Medical Imaging system: Ultra sound, properties, beam width, its generation & detection, types of transducers, diagnostic application – A Scan, B Scan, M Scan.
Radiography- conventional X ray, properties, generation of X-ray, X ray computed tomography (CT scanner) and computer-aided tomography (CAT).

Unit 4 (**12 Lectures)**

Introduction to nuclear medicine system: Nuclear detectors: Gas filled detectors: Ionization, Proportional, and Geiger Muller (GM) Counter, Scintillation counter – principle, operating condition.

Suggested Books:

1. Cromwell L., Wiebell F. J., Pfeiffer EA, Biomedical Instrumentation and Measurements, Prentice Hall, 2nd edition
2. Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Fourth edition, Pearson Education, Inc, 4th edition
3. Khandpur R.S., Handbook of Biomedical Instrumentation, Tata McGraw-Hill Publishing, India, 2nd edition.
4. Joseph D. Bronzino, The Biomedical Engineering Handbook, 2nd Edition, Volume 1, IEEE Press.

Nuclear & Biomedical Instrumentation Lab

(60 Lectures)

1. Characterization of bio potential amplifier for ECG signals.
2. Study on ECG simulator
3. Recording of EEG
4. Measurement of heart sound using electronic stethoscope.
5. Study of pulse rate monitor with alarm system
6. Determination of pulmonary function.
7. Study on ultrasound transducers based on medical system

Machine Intelligence
(Credits: Theory-04, Practicals-02)

Theory Lectures: 60

Unit 1 (**08 Lectures)**

Components of AI, human intelligence vs. machine intelligence, Knowledge Acquisition, Representation and organization: Structured Knowledge representation using Semantic Networks, Frames, Expert system architecture, functions of various parts, Mechanism and role of inference engine, Types of Expert system.

Unit 2 (**21 Lectures)**

Structure and function of a single neuron, artificial neuron models, Types of activation functions, Neural network architectures: Fully connected, layered, acyclic, feed forward, Neural learning: correlation, competitive, Supervised learning: Back propagation algorithm, Unsupervised learning, winner-take all networks, Application areas of neural networks.

Unit 3 (**21 Lectures)**

Fuzziness vs. probability, Crisp logic vs. fuzzy logic, Fuzzy sets and systems, operations on sets, fuzzy relations, membership functions, fuzzification interface, knowledge/rule base, decision making logic, defuzzification interface, Applications of Fuzzy Logic in process Control and motion control

Unit 4 (**10 Lectures)**

Genetic Algorithm: introduction and concept, coding, reproduction, cross-over and mutation Scaling, fitness, applications. **Hybrid Systems**: Introduction to Neuro-fuzzy systems, Fuzzy-Expert system, Fuzzy-GA systems

Suggested Books:

1. Timothy J. Ross, Fuzzy logic with Engineering Applications , McGraw Hill, New York, 3rd Edition
2. S. Rajasekaran, G. A. Vijayalakshmi Pai Neural Networks, Fuzzy Logic And Genetic Algorithm: Synthesis and Applications, PHI Learning Pvt. Ltd., 2003, 1st Edition
3. Martin T. Hagan, Howard B. Demuth, Mark H. Beale, Neural Network Design,PWS Publishing Company, Thomson Learning, 1st Edition
4. N.P. Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press, 1st Edition

Machine Intelligence Lab
(60 Lectures)

Implement programs using Mat lab Fuzzy logic and Neural Network toolbox exemplifying

1. Implementation of perception learning model
2. Pattern recognition using Hopfield network
3. Pattern Identification using associative memories
4. Implementation of back propagation algorithm
5. Implement fuzzy logic operations on fuzzy sets
6. Implement conversion of given crisp variable into its equivalent fuzzy variable
7. Implement conversion of error of given control system into its equivalent fuzzy variable
8. Design model of fuzzy logic PID controller
9. Design fuzzy logic based temperature control system
10. Design fuzzy logic based washing machine/aircraft landing system