PROSPECTUS
OF
MASTER OF SCIENCE IN
ELECTRONICS
Semester-I, Winter 2012
Semester-II, Summer-2013
Semester-III, Winter-2013
Semester-IV, Summer-2014

2012
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Syllabus Prescribed for
M.Sc. Semester-I to IV (Electronics)

M.Sc. Electronics is divided into four semesters which include 16 theory papers, 7 practicals with internal assessment & project work.

Assessment of each theory course is done centrally in the University by the University.

Internal assessment for each practical will be carried out on the basis of (a) Practical record & viva-voce for Practical-I, III, V & VII, (b) *Seminar for Practicals-II, IV, VI & project work.

Internal Assessment for each seminar course will be carried out on the basis of minimum 4 (four) seminars, presented by the students in perodic manner with relevant technical coverage in each seminar, marks for seminar course will be awarded on the overall performance of the student.

The external examination shall consist of-
(a) Theory course ................. Written Examination.
(b) Practical course ............... Practical Examination & viva-voce.
(c) Seminar course............... Oral presentation followed by the questions-answers.
(d) Project ......................... Oral presentation followed by the questions-answers.

Distribution of Marks for Project shall be as under.
(i) Project (Experimental) : 60 Marks
(ii) Guide Report : 20 Marks
(iii) Project Report : 20 Marks

Total 100 Marks

Project:
Execution and documentation of a project on a specific topic with one of the following aspects:
(i) Part of on-going research projects in the deptt.
(ii) Developmental work related to Industrial requirements.
(iii) Theoretical & experimental studies.
(iv) Technical writing & project documentation.

M.Sc. First Year Electronics
Semester-I

Paper-I : 1ELE1-Fundamentals of Semiconductor Devices
Paper-II : 1ELE2-Instrumentation and Measurement Techniques
Paper-III : 1ELE3-Biomedical Instrumentation
Paper-IV : 1ELE4: Optical Electronic Devices and Applications
Practical-I : Atleast 8 Experiments based on Paper-I & II
Practical-II : Atleast 8 Experiments based on Paper-III & IV

M.Sc. First Year Electronics
Semester-II

Paper-V : 2ELE1-Analog Circuit Design And Analysis
Paper-VI : 2ELE2-Microprocessor and Microcontroller
Paper-VII : 2ELE3-Digital IC’S & Design
Paper-VIII : 2ELE4- Mechatronics
Practical-III : Atleast 8 Experiments based on Paper-V & VI
Practical-IV : Atleast 8 Experiments based on Paper-VII & VIII

M.Sc. Second Year Electronics
Semester-III

Paper-IX : 3ELE1- Antenna and Mobile Communications
Paper-X : 3ELE2-Power Electronics
Paper-XI: 3 ELE 3-Advanced Microcontroller and Embedded system
Paper-XII: 3ELE4 - Computer Hardware and Interfacing
Practical V: Atleast 8 Experiments based on Paper-IX & X
Practical VI: Atleast 8 Experiments based on Paper-XI & XII

M.Sc. Second Year Electronics
Semester-IV
Paper-XIII: 4 ELE 1- VLSI Design and VHDL Programming
Paper-XIV: 4ELE2- Virtual Instrumentation
Paper-XV: 4ELE3- Numerical Methods and C Programming
Paper-XVI: 4ELE4- Fuzzy logic and Neural Networks
Practical-VII: Atleast 8 Experiments based on Paper-XIII, XIV, XV & XVI
Project Work: Practical-VIII

Sem-I/ Paper -I
1ELE1-Fundamentals of Semiconductor Devices

Unit I: Conduction in semiconductor: semiconductors, brief idea about band theory of semiconductor, conduction mechanism, carrier concentration and mobility, effect of temperature on electrical conductivity, intrinsic semiconductors, carrier concentration in an intrinsic semiconductor, conduction and valance band, carrier concentration in terms of band gap, electrical conductivity, generation and recombination of charges, extrinsic semiconductor-P type and N type, Hall effect.

Unit II: Junction and Interface: p-n junction, linearly graded and abrupt junctions, diode equation, static I-V characteristics, break-down mechanisms in pn-junction, dynamic behaviour of pn-junction, effect of temperature on pn-junction diode.

Unit III: Special Semiconductor Devices: Gunn effect and diode, zener effect and zener diode, Tunnel diode, PIN diode, varactor diode schottky diode.

Unit IV: Bipolar and unipolar semiconductor devices: Bipolar junction transistor(BJT), principle of operation, fabrication methods and doping profile, analysis of ideal and real transistor, static I-V characteristics in active region, charge control equation. Junction and metal semiconductor field effect transistors, principle of operation, I-V characteristics, MOSFET - basic structure and operating principle, I-V characteristics, charge coupled devices, MESFET’s.


Recommended Books:
1) Sanjeev Gupta: Electronic Devices and Circuits
2) B. L. Thereja: Principles of EDC
3) Jacob Millman: Microelectronics (2nd edition)

Sem-I/ PAPER II
1ELE2- Instrumentation and Measurement Techniques

Unit I: Display Devices and Printers
Digital display system and indicators, classification of displays, display devices, LED, LCD, touch screen displays, Printers: Classification, printer character set, Drum printer, Dot matrix printers, character at a time Dot matrix Impact printer, Non-Impact Dot matrix (NIDM) printer.

Unit II: Digital Instruments
Digital multimeters, Digital frequency meter, Digital Tachometer, Digital pH meter, Automation in Digital Instruments, Digital phase meter, Digital capacitance meter, Microprocessor based instrumentation.

Unit III: General Electronic Test Equipment
Cathode-Ray oscilloscope, Digital voltmeter & multimeter, Electronic counters, AC millivoltmeter, wave analyzers and spectrum analyzer, signal generators, lock in amplifiers, Frequency response analyzer.

Unit IV: Transducers and Signal conditioning
Electrical transducers, Resistive transducers, Strain Gauges, Thermister, LVDT, Piezo electric transducer, Temperature transducers, Mechanical transducers.
Introduction of signal conditioning, block diagram of signal conditioning, Types of filters.

Unit V: Measurement set-up
Measurement of microwave frequencies, Resonant co-axial lines, cavity wavemeters, RF/UHF field strength meter, measurement of sensitivity, intermodulation method, measuring frequency response in Audio amplifiers, measuring amplitude modulation using CRO.

Recommended Books:
1) H. S. Kalsi: Electronic Instrumentation
2) Malestat: Electronics Measurements.
4) E.B. Doblin: Measurement Systems, Application and Design
5) Villiam D. Cooper: Modern Electronic Instrumentation & Measurement techniques

Sem I/ Paper III
1ELE3-Biomedical Instrumentation

Unit I: Fundamentals of Biomedical Instrumentation:
Basic medical instrumentation system, Performance requirements of Medical Instrumentation System, Intelligent Medical Instrumentation System, biometrics.

Unit II: Bioelectric Signals and Electrodes:
Origin of Bioelectric signals, Recording Electrodes, Silver-Silver Chloride Electrodes, Electrodes for ECG, EEG and EMG.

Unit III: Biomedical Recorders:
Electrocardiograph (ECG), vectorcardiograph (VCG), Phonocardiograph (PCG), Electroencephalograph (EEG), Electromyograph (EMG), cardiac pacemakers.

Unit IV: Magnetic Resonance Imaging System:
Principles of NMR Imaging System, Image Reconstruction Techniques, Basic NMR Components, Biological Effect of NMR Imaging, Advantages of NMR, Imaging System, principle of MRI.

Unit V: Radio-therapy Equipment:
Use of high voltage X-ray Machines, Development of Betatron, Cobolt-60 Machine, Medical Linear Accelerator Machine, X-ray tomography, short wave, micro-wavand surgical diathermy.

Recommended Book:
1) R. S. Khandpur (2nd Addition) (McGraw-Hill publication): Biomedical Instrumentation

Sem I/ Paper IV
1ELE4: OPTICAL ELECTRONIC DEVICES AND APPLICATIONS

Unit I: Introduction
Classification of optical fiber, Principal of light transmission through fiber, Fabrication of optical fibers, Material consideration, Loss and band width, limiting mechanism, Mechanical and thermal characteristics, Light sources for fiber optics, Photo detectors, Source coupling, Splines and connectors.

Unit II: Fundamental of Optics
Polarization, diffraction, interference, dispersion holograms. Optical Sources: Light Emitting Diodes (LEDs): Structure, Materials, Characteristics, Efficiency. Liquid Crystal Display (LCD)

Unit III: Photo Detectors
Thermal detectors, Photo detectors, Vacuum photo diode, Photo multiplier tube, Photo conductive detector, LDR, PIN diode.

Unit IV: Optical Instruments
Optical pyrometer, Infrared thermometer, Polarimeter, Light intensity meter, Spectro photo meter, Spectrometer analyzer, X-ray fluoroscopic instruments, Periscope, Optical filters, Beam splitters.

Unit V: Lasers
Different types of lasers: Gas laser, Liquid lasers, Semiconductor lasers.

RECOMMENDED BOOKS
1. Optical fiber communication by John M Senior, Prentice Hall of India, New Delhi
Sem-II/ Paper V

2ELE1-Analog Circuit Design And Analysis


Unit III : Frequency Responce and Linear applications of Op-amp:
Open loop voltage gain as a function of frequency, closed loop frequency response, circuit stability, slew rate, DC and AC amplifiers, Differential LP and OP amplifiers, voltage to current converter with floating load and grounded load, current to voltage converter, the Integrator, Differentiator, Adder and Subtractor.

Unit IV : Active Filters, Comparators and convertors:
Active filters, First and second order Low-pass Butterworth filter, Band-Pass filters, Basic comparator, Zero crossing detector, Schmitt trigger, comparator characteristics, limitations of comparator, window detector, voltage to frequency and frequency to voltage converter, Clippers & Clamps, A to D converter and D to A converter.

Unit V : Specialized IC Applications:
The 555 timer as Monostable, Astable & Bistable multivibrator, PLL: operating principles, monolithic PLL, 565 PLL applications, Voltage Regulators: fixed voltage regulator, Switching regulators, Special regulators.

Recommended Books:
1) Ramakant Gaikwad: Linear Integrated Circuits
2) Analog & Digital techniques: Navneeth, Kale & Gokhale

Sem-II/ Paper VI
2ELE2-Microprocessor and Microcontroller

Unit I: Introduction: Features, Architecture of 8086, Addressing modes: Register and Immediate Modes, Addressing modes for Accessing data in Memory (Memory Modes), Addressing Modes Accessing I/O Ports (I/O Modes), Relative Addressing Mode, Implied Addressing Mode, Instruction Set.

Unit II: System Configurations: Pin Diagram of 8086, Minimum Mode: Pin definitions in minimum mode, Minimum Mode Configuration, Bus Timing for Minimum Mode, Maximum Mode: Pin Definitions in maximum mode, Maximum Mode Configuration, Bus Timing For Maximum mode, Input/output Interfacing: I/O mapped I/O, memory mapped I/O.

Unit III: 8051 Microcontrollers: Microcontrollers and embedded processors, overview of the 8051 family, Inside 8051, 8051 flag bits and the PSW register, 8051 register banks and stack, the program counter and ROM space in the 8051, Data types and Directives.

Unit IV: I/O Port programming & Addressing Modes: Pin description of the 8051, Addressing modes: Immediate & register addressing mode, Accessing Memory using various addressing modes, Bit Addresses for I/O and RAM, Introduction to 8051 Assembly programming, Assembling and running an 8051 program.

Unit V: JUMP, LOOP, and CALL Instructions: Loop and jump instructions, Call instructions, Time delay for various 8051 chips, ARITHMETIC, LOGIC INSTRUCTIONS: Arithmetic instructions, signed number concepts and arithmetic operations, Logic and compare instructions, Rotate instruction and data serialization.

Recommended Books:
1) A.P. Godse: Microprocessor Techniques 8085 & 8086
2) B. Ram: Microprocessor 8085 & 8086
3) Muhammad Ali Mazidi: The 8051 Microcontroller and Embedded Systems
UNIT I: Combinational Logic Design:
Function of binary variables, Boolean Algebraic theorems, standard form of logical functions, K-map up to five variables, Quine Mcclusky method. Don’t care conditions and it’s effects, Synthesis using AND - OR gates.

UNIT II: Combinational logic design using 74/54 series MSI chip series concerning to multiplexers, demultiplexers, decoders, encoders, comparators, code converters, priority encoders parity generator/ checker & BCD-Seven segment decoder.

UNIT III: Combinational logic design using ROM array, PLA, PAL, preliminary design concepts using FPGA's N-bit binary adder using 7480, Look-ahead carry adder construction.

UNIT IV: Design of counter and sequential networks: Analysis of clocked sequential networks, General models of sequential machines, Equivalence and minimization networks, Deviation of state graph and tables, reduction of state assignments, S.M.Chart.

UNIT V: Analysis of asynchronous sequential networks, derivation and reduction of primitive flow tables, state assignments and realization of flow tables, hazards, asynchronous sequential network design.

Recommended Books:
4. Fleatcher: An Engineering approach to Digital System Design “, PHI

UNIT I: Mechatronics:
What is mechatronics, design process, systems, measurement systems, control systems, Programmable logic controller.

UNIT II: Closed loop Controllers:
continuous and discrete control processes, Terminology, Two step mode, Proportional mode, Derivative control, Integral control, PID controller, Digital controllers, Controller tuning, velocity control, Adaptive control.

UNIT III: Programmable Logic Controller :
Programmable logic controller, basic PLC structure, I/P-O/P Processing, Ladder programming, Instruction lists, latching and integral relays, sequencing, timers and Counters, Shift registers, Master and jump controls, data handling.

UNIT IV: Communication Systems :
Digital communications, Centralised, Hierarchical and Distributed control, Networks, Protocols, open systems Interconnection communication model, Serial Communication interfaces, Parallel Communication Interfaces, Wireless protocols

UNIT V: Fault Finding :
Fault - detection Techniques, Watchdog timer, Parity and error coding checks, Common hardware faults, Microprocessor Systems, Emulation and simulation, PLC systems.

Recommended Book:
1) W. Bolton ( 4th edition ) : Mechatronics

SEM –III/paper IX
3ELE1- Antenna and Mobile Communications

Unit I: Antennas
Theory and design of antennas, Antenna parameters - radiation, current elements, radiation resistance, antenna gain, directivity, effective length, antenna aperture; reciprocity theorem
Unit II : Antenna types
Short dipole antenna, antenna arrays: two-element arrays, broadside and end fire arrays, linear arrays, binomial arrays, folded dipole, Yagi-Uda array; traveling wave antenna, rhombic antenna, V-antenna; Horn Antennae, parabolic reflectors, helical antenna, lens antenna, micro-stripe and antenna; antenna measurements such as impedance, radiation pattern, gain, antennas for mobile communication

Unit III : Mobile Communications
Cellular concepts: Introduction to cellular mobile systems, frequency reuse, channel assignment and land off strategy, elements of cellular radio system design, switching and traffic, data links and microwaves, system evaluation

Unit IV : Mobile Radio Environment
Causes of propagation loss, causes of fading; modulation techniques – BPSK, QPSK, QAM and GMSK; fundamentals of equalization, space polarization, frequency and time diversity techniques, channel coding

Unit V : Multiple access Techniques
Introduction to digital system, digital cellular system, GSM & CDMA systems- service features, GSM architecture, GSM channel types, GSM frame structure, intelligent cell concept and applications; Features of handset, SMS, security; Interfacing of mobile with computer, application of mobile handset as modem, data storage device, multimedia device; Measurement of signal strength.

Recommended Books:
3. Electromagnetic waves and radiation systems: E. C. Jordan and K.E. Balmain
4. Antennas; J. D. Krauss (2nd edition, TMH, New Delhi, 1999)
5. Handbook of Antenna: Jasik
6. Wireless Communications and networking : Jon W. Mark & Weihua Zhuang
8. Wireless Digital Communications: Modulation and Spread Spectrum Applications: Dr. Kamilo Feher (PHI, New Delhi, 1999)

Sem-III/Paper X
3ELE2-Power Electronics

Unit I : Power Electronic Systems
Introduction-History, Applications and Interdisciplinary Nature.
Power Electronic Systems Block Diagram, Types of Converter Circuits, Peripheral Effects, Thermal Management and Design Aspects.
Performance Parameter such as Efficiency, Total Harmonic Distortion, Power Factor and Reliability.

Unit II : Power Devices:
Ideal Requirements For Power Electonic Devices.
i) Power Diodes-PIN DIODE, SHOTTKEY DIODE,
ii) Thyristor Devices-SCR,TRIAC,GTO,
iii) Power Transistor Devices-POWER BJT,POWER MOSFET,IGBT
Comparison Of all Power Devices

Unit III : Rectifiers, AC Controllers and Resonant Converter
Rectifiers: Performance Parameters, Single Phase Bridge Rectifier with R and RL Load, Three Phase Bridge Rectifier with R and RL Load, Three Phase Fully Controlled Bridge Rectifier with R and RL Load, Comparison of all Rectifier Circuits.
Resonant Converter: Need of Resonant Converters, their Advantages and Disadvantages, Comparison between PWM and Resonant Converters, Zero Current Switching Converters(ZCS), Zero Voltage Switching Converter (ZVS), Comparison between ZCS and ZVS Converters.

Unit IV : Choppers and Inverters
Choppers: Principle of Operation-Step Up and Step Down Choppers, Performance Parameter, Step Down Converter with
RL Load, Step Up Converter with RL Load, Converter Classification and Operation, Chopper Circuit Design

**Inverters**: Principle Of Operation, Performance Parameter, Single Phase Inverter, Three Phase Inverter, Modulation Technique for Inverters, Inverter Circuit Design

**Unit-V: Applications**

I) **Power Supplies:** DC Power Supplies- i) Switching Regulators—Buck, Boost and Buck-Boost Regulators, ii) SMPS—Flyback, Push-Pull, Bridge Converter. AC Power Supplies—UPS—Online, Offline and Interactive.

II) **Motor Drives:** Comparison Of Motors, Types of Motor Drives, Equivalent Circuits, Mathematical Equations, Principle of Operation, Torque-Speed Characteristics, Selection Criteria, Performance Parameter.
   i) AC Motor Drives—Squirrel-Cage induction motor.
   ii) DC Motor Drives (chopper drives)— Separately Excited DC Motor, PMDC.
   iii) Synchronous Motor (PWM Inverter) Drives—BLDC, PMSM.

**Recommended Books:**
1) M.H.Rashid: Power Electronics—Circuits, Devices and Applications
2) P.C.Sen: Power Electronics
3) Ned Mohan: Power Electronics—Converters, Applications and Design

**Sem III/Paper XI**

3 ELE 3: Advanced Microcontroller and Embedded System

**Unit-I: PIC Microcontroller & Interfacing:**
Introduction, architecture (PIC 16C6X), registers, instruction set, addressing modes, timers, interrupt timing, i/o port expansion-serial peripheral interface, LCD display, I2C bus operation, serial EPROM, DAC, Temp. Sensors, ADC, UART, oscillator configuration, low power operation, serial programming & parallel slave port.

**Unit-II: ARM & AVR Processors:**
RISC, ARM design philosophy, ARM fundamentals, instruction sets, thumb instruction sets, exception & interrupt handling, efficient C programming, optimizing ARM assembly code, AVR architecture, instruction set, hardware interfacing, communication links & design issues.

**Unit-III: Introduction to Embedded Systems:**
Introduction to Embedded system, features of embedded system, components of embedded system, processor selection, device drivers, interrupt servicing mechanism.
examples of embedded system application.

**UNIT IV: Embedded System Hardware:**
Interfacing: I/O devices (LCD, Keyboard, ADC, DAC, Stepper motor, PWM etc.), Data converters, DMA, UART, SPI, PWM, WDT, Memories, serial, parallel Asynchronous and synchronous communication.

**UNIT V: Development tools for embedded systems:**
Software development tools- Editor, Assembler, linker, simulator, compiler Hardware development tools: programmer (EPROM programmer, microcontroller programmer, universal programmer), Logic analyzer, General purpose evaluation Boards.
Hardware and Software combination Tools-1. In circuit emulator 2. Debugger.

**Recommended Books:**
4) David Simon, “An Embedded Software Primer”, Pearson education, Asia
SEM III/XII
3ELE4 - COMPUTER HARDWARE AND INTERFACING

UNIT I: CPU AND MEMORY

UNIT II: MOTHERBOARDS

UNIT III: STORAGE DEVICES

UNIT IV: I/O PERIPHERALS

UNIT V: BUS ARCHITECTURE

TEXT BOOK:

Sem IV/ Paper XIII
4 ELE 1- VLSI Design and VHDL Programming

UNIT I: Introduction to CMOS / VLSI Circuits, MOS transistor switch, Realization of universal gates and compound gates using MOS transistors, Fundamentals of circuit characterization and performance estimation, Basics of R, L and C estimation, CMOS circuits and Logic design, Transistor sizing, basic physical design of simple logic gates.

UNIT 2: CMOS system design And Design Methods, CMOS testing, CMOS subsystem design, Floorplanning, Placement, Physical design flow, Information Formats, Global Routing, Detailed Routing, Special Routing.

UNIT 3: ASIC construction And CMOS Design:-Physical design, CAD tools, System Partitioning, Estimating ASIC size, Power dissipation, FPGA partitioning methods.

UNIT 4: Introduction to VHDL, Behavioral Modeling, sequential Processing, data types, attributes, configurations, synthesis and synthesis issues, RTL simulation, place and route. Introduction to VERILOG.

UNIT 5: Design of combinational blocks such as multibit address, ALU, MUX, DEMUX, encoders, decoders, Design of Sequential circuits, asynchronous and synchronous design Issues

Recommended Books:
2) J. Bhaskar : “VHDL Primer”, (Person Education)
4) Application Specific IC” Michael John Sebastiab Smith Addison Wesley Publication.
Unit I: Virtual Instrumentation
Traditional bench top instruments, general functional description of a digital instrument, block diagram of a virtual instrument, user interface, advantages of virtual instrument over conventional instruments, architecture of a virtual instrument & its relation to the operating system, data flow techniques, other virtual programming environments.

Unit II: Virtual Instrument Programming Techniques
VIs and sub VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, instrument drivers.

Unit III: Data Acquisition Basics
Introduction to data acquisition on PC, concepts of data acquisition and terminology, sampling fundamentals, I/O techniques and buses, ADC, DAC, digital I/O, counters and timers, DMA, buffered I/O, real time data acquisition, calibration, resolution, data acquisition interface requirements.

Unit IV: Virtual Instrument Chassis Requirements
Common instrument interface: Current loop, RS232/RS485, GPIB systems basics; interface basics: USB, PCMCIA, VXI, SCXI, PXI, Firewire; PXI system controllers; Ethernet control of PXI;

Unit V: Virtual Instrument Analysis Toolsets
Distributed I/O modules, Applications of VI, Instrument control, simulations of systems, Fourier Transform, power spectrum, correlation methods, windowing & filtering, P, PI, and PID module handling, virtual system design in temperature, pressure, humidity, image acquisition and processing, motion control, database programming.

Recommended Books:

Unit I: Basic structure of C programme, programming style, executing c programme, constants, variables & data types, operators, I/P and O/P operations, Branching & looping.

Unit II: Arrays: One diamentional, two diamentional, multidiamentional, their declaration & initialization. Character & Strings: Declaring & initializing string variables, reading & writing of string variables, arithmatic operations on characters, comparision of strings.
Userdefind function: Need, defination, return values & their types, function calls, declaration, nesting of functions, passing arrays & string to function.

Unit III: Structures: Definition, declaration initialization, copying and comparing structure variable,arrays of structure, structures and functions, size of structures.
Pointers: Introduction, accessing the address of variables, initialization of pointer variables, chain of pointer, pointer expression, pointers & arrays, pointers & character strings, pointer to function & structure File management in C.

Direct solution & Linear equation: Need and scope, existance of solution, solution by elimination, Basic Gauss elimination method with pivoting, Jacobis Iteration method, Gauss seidel method.

Unit V: Curve fitting: Interpolation: introduction, polynomial, forms, linear interpolation, spline interpolation.
Regeration: Introduction, fitting linear equation, fitting transcendental equation, fitting a polynomial function.
Numerical Differential Integration: Need & Scope, Differentiating, continuous function, Differentiating Tabulated function, Trapezoidal Rule, Taylor's series method, Euler's method.

**Recommended Books:**
1. E. Balguruswami: ANCII C
2. E. Balguruswami: Numerical Methods
3. Shastri: Numerical Methods

Sem-IV/Paper XVI
4ELE4- Fuzzy logic and Neural Networks

**Unit I:** Introduction: Utility of Fuzzy systems, uncertainty and information, fuzzy sets and Membership, chance versus fuzziness.

Classical set and fuzzy sets: Classical set, operation on classical set, properties of classical set, fuzzy set, fuzzy set operation, properties of fuzzy sets, non interactive fuzzy sets.

Classical Relation and Fuzzy relation: Cartesian product, crisp relation, operation on crisp relation, properties of crisp relations, operation on fuzzy relations, properties of fuzzy relation.

**Unit II:** Properties of membership function, Fuzzification & Defuzzification: Features of the membership function, fuzzification, defuzzification to crisp set.


Development of membership function: Membership value assignment, membership function generation.

**Unit III:** Fuzzy Systems simulation: introduction, fuzzy relational equations, non-linear simulation using fuzzy systems, Fuzzy Associative Memories (FAMs).

Rule-Base reduction methods: Fuzzy systems theory and rule reduction methods.

Decision making with fuzzy information: introduction, fuzzy synthetic evaluation, fuzzy ordering, non transitive ranking, preferences and consensus, multiobjective decision making, fuzzy Bayesian decision making, decision making under fuzzy states and fuzzy actions.

**Unit IV:** Neural and Fuzzy machine Intelligence: Neural and fuzzy systems as function estimators, neural network as trainable dynamical system.

Neural network Theory: Neurons as functions, signal monotonicity, biological activation & signals, Neuron fields, neuronal dynamical system, additive neural dynamics, additive neural feedback, additive activation model, additive Bivalent model.

**UNIT V:** Unsupervised learning in Neural Networks: Four unsupervised learning laws, probability spaces and random processes, stochastic unsupervised learning and stochastic equilibrium, signal Hebbian learning, competitive learning, differential Hebbian learning.

**Recommended Books:**

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