KUVEMPU UNIVERSITY
Department of Electronics
Jnanasahyadri –577 451

Scheme of M.Sc. Electronics Syllabus (NEW)

I Semester:

SUBJECT CODE	SUBJECT	TH/PR	IA	CREDITS	TOTAL
ELH - 1.1	Programming in C++	75	25	4	100
ELH - 1.2	Microwave Devices & Antennas	75	25	4	100
ELH - 1.3	Pic & Arm Microcontroller	75	25	4	100
ELH - 1.4	Signals and Systems	75	25	4	100
ELP - 1.5	Microcontroller Lab	50	-	2	50
ELP - 1.6	Programming in C++ Lab	50	-	2	50
ELP – 1.7	S & S -Lab	50	-	2	50
			TOTAL	**22**	**550**

Seminars: Network Analysis, Advance digital systems

II Semester:

SUBJECT CODE	SUBJECT	TH/PR	IA	CREDITS	TOTAL
ELH - 2.1	Control systems	75	25	4	100
ELH - 2.2	Digital design using Verilog	75	25	4	100
ELH - 2.3	Digital Signal Processing	75	25	4	100
ELS	**Soft Core Subject**	75	25	4	100
ELE - 2.5	Basic Electronics (Ele)	40	10	2	50
ELP - 2.6	Control system Lab	50	-	2	50
ELP - 2.7	Digital Signal Processing Lab	50	-	2	50
ELP – 2.8	Verilog Lab	50	-	2	50
			TOTAL	**24**	**600**

Soft Core Subjects: ELS -2.4.1 Power Electronics
ELS -2.4.2 Wireless Communication & Satellite Communication

Seminars: Linear Algebra, Statistics

III Semester:

SUBJECT CODE	SUBJECT	TH/PR	IA	CREDITS	TOTAL
ELH - 3.1	Advanced Digital Communication	75	25	4	100
ELH - 3.2	Advanced Computer Networks	75	25	4	100
ELH - 3.3	Image Processing	75	25	4	100
ELS	**Soft Core Subject**	75	25	4	100
ELE - 3.5	Fundamentals of Digital Electronics (Ele)	40	10	2	50
ELP - 3.6	Advanced Digital Communication Lab	50	-	2	50
ELP - 3.7	CCNLab	50	-	2	50
ELP – 3.8	Image processing Lab	50	-	2	50
ELR-3.9	Industrial Training	50	-	2	50
			TOTAL	**26**	**650**

Soft Core Subjects: ELS -3.4.1 Information theory & coding
ELS -3.4.2 Multimedia

Seminars: Artificial Intelligence, Internet of Things

IV Semester:

SUBJECT CODE	SUBJECT	TH/PR	IA	CREDITS	TOTAL
ELH- 4.1	VLSI Design	75	25	4	100
ELH- 4.2	Machine Learning	75	25	4	100
ELH- 4.3	Embedded systems	75	25	4	100
ELH – 4.4	Pattern Recognition	75	25	4	100
ELP- 4.5	Pattern recognition Lab	50	-	2	50
ELP – 4.6	VLSI Lab	50	-	2	50
ELP- 4.7	Project Work + Industrial visit	75	25(viva)	4	100
			TOTAL	**24**	**600**

TOTAL MARKS AND CREDITS

SL.NO	SEMESTER	CREDITS	MARKS
1	FIRST	22	550
2	SECOND	24	600
3	THIRD	26	650
4	FOURTH	24	600
GRAND TOTAL		**96**	**2400**

ELH: 1.1 PROGRAMMING IN C++

Course objectives: This course will enable students to explain fundamentals of data structures and their applications essential for programming/problem solving, Analyze Linear Data Structures: Stack, Queues, Lists, Analyze Non Linear Data Structures: Trees, Assess appropriate data structure during program development/Problem Solving, Analyze the operations of Linear Data structures: Stack, Queue and Linked List and their applications.

UNIT I **20 hrs**

Introduction: Object oriented programming, characteristics of an object-oriented language.

C++ programming language: Tokens, keywords, identifier and constants, basic data types, userdefined data types, derived data types, arithmetic operators, relational operators, logical operators, assignment operators, increment and decrement operators.

Decision making, branching and looping: if, if-else, else-if, switch statement, break, continue andgo to statement, for loop, while loop and do loop.

Functions: Function definition, function arguments and passing, returning values from functions, referencing arguments, function overloading, virtual functions, library functions, local, static and global variables.

UNIT II **20 hrs**

Data Structures: Arrays, pointers, storage classes dynamic memory allocation, introduction to stacks, queues, linked list and trees. **Classes and objects:** Classes and objects, member functions, class constructors and destructors,array of objects, operator overloading. **Class inheritance:** Derived class and base class, multiple inheritance, polymorphism.

UNIT III **20 hrs**

Managing Console I/O Operation: C++ streams, C++ stream classes, unformatted I/O operations, formatted console I/O operations, managing output with manipulators. **Working with files:** Classes for file stream operations, opening and closing a file, detecting end-offile, file modes, file pointers and their manipulations, updating a file, error handling during file operations, command-line arguments. **Templates: c**lass templates, class templates with multiple parameters, function templates, functiontemplates with multiple parameters, overloading of template function, member function templates, non-type template arguments. **Exception handling:** basics of exception handling, exception handling mechanism, throwingmechanism, catching mechanism, rethrowing an exception, specifying exception.

Introduction to the standard template library: components of STL, containers, algorithms,iterators, application of container classes, function objects.

Manipulating strings: creating string objects, manipulating string objects, relational operations,string characteristics, accessing characters in strings, comparing and swapping.

Text Book:

1. Object- oriented programming with C++: Balagurusamy E, TMH, 2005

References:

1. The Waite group's object oriented programming in Turbo C++: Robert Lafore, Galgotia Publication. Pvt. Ltd, 2005.

ELH - 1.2 MICROWAVES AND ANTENNAS

Course objectives: This course will enable students to: Describe the microwave properties and its transmission media. Describe microwave devices for several applications. Understand the basics of antenna theory. Select antennas for specific applications

UNIT I 20 hrs

Microwave Tubes: Introduction, Reflex Klystron Oscillator, Mechanism of Oscillations, Modes of Oscillations, Mode Curve
Microwave Network theory: Symmetrical Z and Y-Parameters for Reciprocal Networks,S matrix representation of Multi-Port Networks.
Microwave Passive Devices: Coaxial Connectors and Adapters, Attenuators, PhaseShifters, Waveguide Tees, Magic tees.
Microwave Transmission Lines: Microwave Frequencies, Microwave devices, Microwave Systems, Transmission Line equations and solutions, Reflection Coefficient and Transmission Coefficient, Standing Wave and Standing Wave Ratio, Smith Chart, Single Stub matching.

UNIT II **20 hrs**

Antenna Basics: Introduction, Basic Antenna Parameters, Patterns, Beam Area, Radiation Intensity, Beam Efficiency, Directivity and Gain, Antenna Apertures, Effective Height, Bandwidth, Radio Communication Link, Antenna Field Zones & Polarization
Electric Dipoles: Introduction, Short Electric Dipole, Fields of a Short Dipole (General and Far Field Analyses), Radiation Resistance of a Short Dipole, Thin Linear Antenna (Field Analyses), Radiation Resistances of Lambda/2 Antenna.

Point Sources and Arrays: Introduction, Point Sources, Power Patterns, Power Theorem, Radiation Intensity, Field Patterns, Phase Patterns, Arrays of Two Isotropic Point Sources, Pattern Multiplication, Linear Arrays of n Isotropic Point Sources of equal Amplitude and Spacing.

UNIT III **20 hrs**

Antenna Types
Loop and Horn Antenna: Introduction, Small loop, Comparison of Far fields of Small Loop and Short Dipole, The Loop Antenna General Case, Far field Patterns of Circular Loop Antenna with Uniform Current, Radiation Resistance of Loops, Directivity of Circular Loop Antennas with Uniform Current, Horn antennas Rectangular Horn Antennas. Helical Antenna, Helical Geometry, Practical Design Considerations of Helical Antenna, Yagi-Uda array, Parabola General Properties, Log Periodic Antenna.
Strip Lines: Introduction, Micro Strip lines, Parallel Strip lines, Coplanar Strip lines,Shielded Strip Lines.

Text Books:
1. Microwave Devices and circuits- Liao, Pearson Education.
3.Antennas and Wave Propagation, John D. Krauss, Ronald J Marhefka and Ahmad S Khan,4th Special Indian Edition , McGraw- Hill Education Pvt. Ltd., 2010.
3. . Electromagnetic Waves and Radiating systems – E CJordan and K G Balmin , Printice-hall
Reference Books:
1. Microwave Engineering – Sushrut Das, Oxford Higher Education, 2ndEdn, 2015.

ELH: 1.3 PIC & ARM MICROCONTROLLER

Course objectives: This course will enable students to: Study of architecture of Basic Microcontroller, PIC & ARM microcontrollers. Program PIC & ARM microcontrollers Understand Interface of microcontroller and peripherals

UNIT I 20 hrs

Microcotrollers: Introduction, different types of microcontrollers, embedded microcontrollers, processor architectures. Harvard vs. Princeton, CISC vs. RISC architectures, microcontroller memory types, microcontroller features, clocking, I/O pins, interrupts, timers, peripherals.

PIC16F887 microcontroller

Core features, pin diagram, device overview, memory organization, I/O ports, oscillator module, Timer), Timer1 and Timer2 Module, comparator module, Analog-to-digital converter (ADC) module, data EEPROM and flash program memory control, enhanced capture/compare/PWM module, EUSART, master synchronous serial port (MSSP) module, special features of the CPU, insruction set, addressing modes.

UNIT II 20 hrs

ARM Processor: Introduction to embedded systems, arm embedded systems, arm processor fundamentals: Registers, current program status register, pipeline exceptions, interrupts the vector table, core extentions, arm processor families. Arm instruction Set: Introduction, data processing instructions, branch instructions, load store instructions, software interrupt instructions, program status register instructions and co-processor instructions. Architectural support for high level languages: Data types , floating point data types, arm floating point architecture, expressions, conditional statements, loops, functions and procedures.

UNIT III 20 hrs

Interfacing with pic microcontroller: Interfacing of stepper motor and Rotating stepper motor by N steps clockwise/anticlockwise with speed control. Generate sine, square, saw tooth, triangular and staircase waveform using DAC interface. Display of 4- digit decimal number using the multiplexed 7-segment display interface. LCD (2X16) interfacing. Analog to digital conversion using internal ADC and display the result on LCD. Speed control of DC motor using PWM (pulse delay to be implemented using timers). Interfacing of matrix keyboard (4X4). Serial communication between microcontroller and PC.

TEXT BOOKS:

1. ARM system developer's guide Book by Andrew N Sloss

2. Joseph Yiu, "The Definitive Guide to the ARM Cortex-M3", 2nd Edition, Newnes, (Elsevier), 2010.

Reference Book:

1. "Microcontrollers: Architecture, Programming, Interfacing and System Design**",** Raj Kamal, Pearson Education, 2005.
2. "The 8051 Microcontroller and Embedded Systems – using assembly and C ", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 / Pearson, 2006.

ELH - 1.4 SIGNALS AND SYSTEMS

Course objectives: This course will enable students to: Understand Classify signals and systems
Analyze the signals in time domain using convolution difference/differential equations Classify signals into different categories based on their properties. Determine performance of a system in time & frequency domain Analyze Linear Time Invariant (LTI) systems in time and transform domains. Determine stability of a system using Z-Transforms. Build basics for understanding of courses such as signal processing, control system and communication

UNIT I 20 hrs

Classification of signals: Definition of signal and systems, communication and control systems as examples. Sampling of analog signals, Continuous time and discrete time signal, Classification of signals as even, odd, periodic and non-periodic, deterministic and non-deterministic, energy and power.
Elementary signals/Functions: Exponential, sine, impulse, step and its properties, ramp, rectangular, triangular, signum, sync functions. Operations on signals: Amplitude scaling, addition, multiplication, differentiation, integration (Accumulator for DT), time scaling, time shifting and time folding. Systems: Definition, Classification: linear and non-linear, time variant and invariant, causal and non- causal, static and dynamic, stable and unstable, invertible.

UNIT II 20 hrs

Time domain representations for Linear Time Invariant (LTI) systems: Introduction, convolution, impulse response representation for LTI systems, properties of impulse response representation for LTI systems, differential and difference equations, representation of LTI systems, block diagram representations

Fourier representation of signals: Discrete time periodic signals, Discrete Time Fourier Series (DTFS), continuous time periodic signals, Fourier series, discrete time non periodic signals, Fourier transforms, properties of Fourier representations

UNIT III 20 hrs

Application of Fourier representations: Fourier transform representations for periodic signals, convolution and modulations Fourier transform representation for discrete time signals, sampling, reconstruction of continuous time signals

Z, Transforms: Introduction, Z-transform, properties of Region of Convergence (ROC), Properties of Z - transforms, inversion of Z- transforms, transform analysis of LTI systems, unilateral Z, transforms

Text books:

1.Simon Haykin, Barry Van Veen, “Signals and Systems”, John Wiley & Sons (Asia) Pvt. Ltd. 2002.

Reference books:

1.John G Proakis and Dinitris G Manolakis, Digital Signal Processing, Principles Algorithms and Applications, PHI, 3rd edn. 1997
2.Ganesh Rao and Satish Tunga, “Signals and Systems”, Pearson/Sanguine Technical Publishers, 2004
3. J S Chittode, Signals & Systems,Technical Publications 2009

ELH 2.1 CONTROL SYSTEMS

Course objectives: This course will enable students to: Know the basic features, configurations and application of control systems. Know various terminologies and definitions of control systems. Learn how to find a mathematical model of electrical, mechanical and electro-mechanical systems. Know how to find time & frequency response from the transfer function. Determine the stability of a system in the time & Frequency domain Model a control system in continuous and discrete time using state variable techniques

UNIT I 20 hrs

Modeling of Systems: The control system, Mathematical models of physical systems – Introduction, Differential equations of physical systems – Mechanical systems, Friction, Translational systems (Mechanical accelerometer, Levered systems excluded), Rotational systems, Gear trains, Electrical systems, Analogous systems. Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra, Signal Flow graphs (State variable formulation excluded), Time Response of feed back control systems: Standard test signals, Unit step response of First and second order systems, Time response specifications, Time response specifications of second order systems, steady – state errors and error constants.

UNIT II 20 hrs

Stability analysis: Concepts of stability, Necessary conditions for Stability, Routh- stability criterion, Relative stability analysis; More on the Routh stability criterion. Frequency domain analysis and stability: Correlation between time and frequency response, Bode Plots, Experimental determination of transfer function. Introduction to Polar Plots, (Inverse Polar Plots excluded) Mathematical preliminaries, Nyquist Stability criterion, (Systems with transportation lag excluded) Introduction to lead, lag and lead-lag compensating networks.

UNIT III 20 hrs

Introduction to Digital Control System: Introduction, Spectrum Analysis of Sampling process, Signalreconstruction, Difference equations. Introduction to State variable analysis: Introduction, Concept of State, State variables & State model, State model for Linear Continuous & Discrete time systems, Diaganolisation.Design of Control Systems: Introduction, Design with the PD Controller, Design with the PI Controller, Design with the PID Controller, Design with Phase-Lead Controller, Design with Phase - Lag Controller, Design with Lead-Lag Controller.

Text book :

1. J. Nagarath and M.Gopal, "Control Systems Engineering", New Age International (P) Limited, Publishers, Fourth edition – 2005

Reference books:

1. "Modern Control Engineering ", K. Ogata, Pearson Education Asia/ PHI, 4th Edition, 2002.
2. "Concepts of Control Systems", P. S. Satyanarayana; Dynaram publishers, B'lore, 2001
3. "Control Systems – Principles and Design", M. Gopal, TMH, 1999

ELH - 2.2 Digital design using Verilog

Course objectives: This course will enable students to:Differentiate between Verilog and VHDL descriptions. Learn different Verilog HDL and VHDL constructs. Familiarize the different levels of abstraction in Verilog. Understand Verilog Tasks and Directives. Understand timing and delay Simulation. Learn VHDL at design levels of data flow, behavioral and structural for effective modeling of digital circuits.

UNIT I 20 hrs

Overview of Digital Design Digital systems and embedded systems, real world circuits, models, design, methodology, combinational basics: Combinational components and verification of combinational circuits, sequential basics: Sequential data paths and control clocked synchronous timing methodology.
Verilog HDL: Evolution of CAD, emergence of HDLs, typical HDL-flow, why Verilog HDL?, trends in HDLs. **Hierarchical Modeling Concepts:** Top-down and bottom-up design methodology, differences between modules and module instances, parts of a simulation, design block, stimulus block.

UNIT II **20 hrs**

Basic Concepts: Lexical conventions, data types, system tasks, compiler directives. **Modules and Ports:** Module definition, port declaration, connecting ports, hierarchical name referencing.

Gate-Level Modeling
Modeling using basic Verilog gate primitives, description of and/or and buf/not type gates, rise, fall and turn-off delays, min, max, and typical delays. **Dataflow Modeling:** Continuous assignments, delay specification, expressions, operators, operands, operator types.

UNIT III **20 hrs**

Behavioral Modeling
Structured procedures, initial and always, blocking and non-blocking statements, delay control, generate statement, event control, conditional statements, Multiway branching, loops, sequential and parallel blocks.
Tasks and Functions: Differences between tasks and functions, declaration, invocation.

Text Books:

1. Samir Palnitkar, ―Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition.
2. Kevin Skahill, ―VHDL for Programmable Logic‖, PHI/Pearson education, 2006.

Reference Books:

1. Donald E. Thomas, Philip R. Moorby, ―The Verilog Hardware Description Language‖, Springer Science+Business Media, LLC, Fifth edition.
2. Michael D. Ciletti, ―Advanced Digital Design with the Verilog HDL‖ Pearson (Prentice Hall), Second edition.
3. Padmanabhan, Tripura Sundari, ―Design through Verilog HDL‖, Wiley, 2016 or earlier.

ELH - 2.3 DIGITAL SIGNAL PROCESSING

Course objectives: This course will enable students to: Understand the frequency domain sampling and reconstruction of discrete time signals. Study the properties and the development of efficient algorithms for the computation of DFT. Realization of FIR and IIR filters in different structural forms. Learn the procedures to design of IIR filters from the analog filters using impulse invariance and bilinear transformation. Study the different windows used in the design of FIR filters and design appropriate filters based on the specifications.

UNIT I **20 hrs**

Discrete Time Signals In Frequency domain: Discrete Time Fourier Transform (DTFT**) Discrete Fourier transform (DFT):** Introduction, Definition of DFT: Linearity, Circular shift of a sequence, Symmetry properties, Circular convolution, Linear convolution using DFT. **Computation DFT:** Introduction to FFT, Decimation-in-time FFT algorithm and in-place computations, and Decimation-in-frequency FFT algorithm and in-place computations,

LTI DTS in Frequency domain, transfer function, frequency response

UNIT II **20 hrs**

Digital Filters: simple digital filters, All pass functions, complimentary transfer functions, digital two pairs, Sampling and reconstruction. **Analog Filter Design:** The filter problem, maximally flat low-pass filter approximation, Chebyshev Filter approximation, Frequency transformation. **Digital Filter Structures:** Direct, parallel, cascade, ladder and lattice for IIR, Possible realizations for FIR, including pollyphase, all pass structures, tunable filters

UNIT III **20 hrs**

Digital Filter Design: IIR Filter Design: using Impulse invariance and Bi Linear transformations,Spectral transformations, FIR Filter Design using winnowing, frequency sampling and computer aids. Difference between IIR and FIR .

Text books:

1) "Digital Signal Processing", Rabiner and Gold, Prentice Hall of India Ltd.
2) "Network Analysis and Synthesis", F.F. Kuo, John Wiley & Sons, 7th Edition

Reference books:

1) "Digital Signal Processing", Proakis, Prentice Hall of India Ltd.
2) "Digital Signal Processing", Sanjit. K. Mitra, Tata-McGraw Hill.

ELE - 2.5 BASIC ELECTRONICS (ELE)

Course Objectives: This course offered to other discipline students to provide basic knowledge of electronics. It gives a overview of building blocks of electronic devises and systems.

UNIT I **16 hrs**

Amplifiers & oscillators: Decibels and Half power points, Single Stage CE Amplifier and Capacitor coupled two stage CE amplifier(Qualitative discussions only), Series voltage negative feedback and Additional effects of Negative feed back(Qualitative discussions only), The Barkhausen Criterion for Oscillations, BJT RC phase shift oscillator, Hartley ,Colpitts and crystal oscillator (Qualitative discussions only).
Introduction to operational amplifiers: Ideal OPAMP, Saturable property of an OP AMP inverting and non inverting OPAMP circuits, need for OPAMP, Characteristics and applications - voltage follower, addition, subtraction, integration, differentiation.

Communication Systems: Introduction, Elements ofCommunication Systems, Modulation: Amplitude Modulation, Spectrum Power, AM Detection (Demodulation), Frequency and Phase Modulation. Amplitude and Frequency Modulation:

UNIT II **16 hrs**

Transducers: Introduction, Passive Electrical Transducers, Resistive Transducers, Resistance Thermometers, Thermistor. Linear Variable Differential Transformer (LVDT). Active Electrical Transducers, Piezoelectric Transducer, Photoelectric Transducer. Voltmeter, Ammeter, Multimeter, Oscilloscope.

Flip-Flops: Introduction to Flip-Flops, NAND Gate Latch/ NOR Gate Latch, RS Flip-Flop,
Microcontrollers: Introduction to Microcontrollers, 8051 Microcontroller Architecture and an example of Microcontroller based stepper motor control system (only Block Diagram approach).

Textbooks:

1. Integrated Electronics: Millman and Halkias
   1. Electronic Instrumentation – H. S Kalsi
   2. Basic electronics – D. P. Kothari and I J Nagrath
   3. Digital Electronics – Morris Mano

Referencebooks:

1. Basic Electronics – Punagin.

ELS: 2.4.1 POWER ELECTRONICS

Course objectives: This course will enable students to learn: Thyristors, power MOSFETs, power transistors, IGBT, MCT, LTT, smart power devices. Thyristor circuits: Converters, Inverters and motors operation and design.

UNIT I 20 hrs

Introduction - Applications of Power Electronics, Power Semiconductor Devices, Control Characteristics of Power Devices, types of Power Electronic Circuits. Power Transistors: Power BJTs: Steady state characteristics. Power MOSFETs: device operation, switching characteristics, IGBTs: device operation, output and transfer characteristics.

Thyristors - Introduction, Principle of Operation of SCR, Static Anode- Cathode Characteristics of SCR, Two transistor model of SCR, Gate Characteristics of SCR, Turn-ON Methods, Turn-OFF Mechanism, Turn-OFF Methods: Natural and Forced Commutation – Class A and Class B types, Gate Trigger Circuit: Resistance Firing Circuit, Resistance capacitance firing circuit.

UNIT II 20 hrs

Controlled Rectifiers - Introduction, principle of phase controlled converter operation, Single phase full converters, Single phase dual converters. AC Voltage Controllers - Introduction, Principles of ON-OFF Control, Principle of Phase Control, Single phase control with resistive and inductive loads.

Cycloconverters: Principle of cycloconverter operation, single-phase to single-phase circuit step-up and step-down cycloconverter, three-phase half wave cycloconverter, output voltage equation of a cycloconverter, load commutated cycloconverter. Principle of operation, single-phase voltage source inverters, basic series and parallel inverter circuits, types of inverters, three-phase bridge inverters, voltage control in single-phase inverters, pulse-width modulated inverters, current source inverters.

UNIT III 20 hrs

Choppers: Basic principle, control strategies, step-up and step-down choppers, types of chopper circuits, forced and load commutated chopper circuits.

Introduction to motors: Classification of motors.DC motors: Working principle of DC motor, shunt motor, series motor, starter, closed loop control of DC drive, PLL control of DC drive.

AC motors: Working principle of AC motor, types of AC motors, torque speed characteristics of induction motor, single phase induction motor drive, three phase induction motor drive, speed control of induction motor – stator voltage control and V/F control, synchronous motor, working principle of synchronous motor.

Text Books:

1. Power Electronics: Bimbhra P S, Khanna publishers, 2003.
2. Power Electronics Circuit devices and applications: Rashid M H, PHI,

References:

1. Thyristor Engineering: Berde M S, Khanna publishers,
2. Power Electronics: VedamSubrahmanyam, New Age International, 2002
3. Modern Power Electronics and AC Drives: BimalK.Bose, Pearson education, 2002.
4. Power Electronics: Mohan, Undeland, Robbins, John Wiley, 2003

ELS: 2.4.2 WIRELESS COMMUNICATION AND SATELLITE COMMUNICATION

UNIT I 20 hrs

Wireless Communication Systems: Evolution of mobile radio communications. Examples of wireless communication systems. Paging systems. Cordless telephone systems. Comparison of various wireless systems. Modern Wireless Communication Systems: Second generation cellular networks. Third generation wireless networks. Wireless in local loop. Wireless local area networks. Blue tooth and Personal area networks.

Cellular System Design Fundamentals: Spectrum Allocation. Basic Cellular System. Frequency reuse. Channel assignment strategies. Handoff Strategies. Interference and system capacity, Trunking and grade off service. Improving coverage and capacity, cell splitting.

UNIT II 20 hrs

Multiple Access Techniques For Wireless Communication: introduction to multiple access. FDMA. TDMA. Spread spectrum multiple access. Space division multiple access. Packet radio. Capacity of a cellular systems.

Wireless Networking: Difference between wireless and fixed telephone networks. Development of wireless networks. Fixed network transmission hierarchy. Traffic routing in wireless networks. Wireless data services. Common channel signaling.

Orthogonal Frequency Division Multiplexing: Basic Principles of Orthogonality. Single Versus Multi channel Systems. OFDM Block Diagram and its explanation. OFDM Signal mathematical representation.

UNIT III 20 hrs

Satellite Orbits and Trajectories: Definition, Basic Principles, Orbital parameters, Injection velocity and satellite trajectory, Types of Satellite orbits, Orbital perturbations, Satellite stabilization, Orbital effects on satellite's performance, Eclipses, Look angles: Azimuth angle, Elevation angle.

Satellite subsystem: Power supply subsystem, Attitude and Orbit control, Tracking, Telemetry and command subsystem, Payload. Earth Station: Types of earth station, Architecture, Design considerations, Testing, Earth station Hardware, Satellite tracking.

Communication Satellites: Introduction, Related Applications, Frequency Bands, Payloads, Satellite Vs. Terrestrial Networks, Satellite Telephony, Satellite Television, Satellite radio, Regional satellite Systems, National Satellite Systems.

Wireless Communication

TEXT BOOKS:

1. Wireless Networks: Applications and Protocols, T. S. Rappaport, Pearson Education
2. Wireless Communication and Networks : 3G and Beyond, I. Saha Misra, TMH Education.
3. Wireless Communications : Principles and Practice, T.S.Rappaport, PHI Learning.
4. Wireless Communications, A. Goldsmith, Cambridge University Press.

REFERENCE BOOKS:

1. Lee's Essentials of Wireless Communications, MH Prof. Med/Tech
2. Wireless Digital Communications: Modulations and Spread Spectrum Applications, K. Feher, Prentice Hall.
3. Wireless Communications and Networking, J.W.Mark and W. Zhuang, PHI.

Satellite Communication

Text Book:

Anil K. Maini, Varsha Agrawal, Satellite Communications, Wiley India Pvt. Ltd., 2015, ISBN: 978-81-265-2071-8.

Reference Books :

1. Dennis Roddy, Satellite Communications, 4th Edition, McGraw- Hill International edition, 2006

2. Timothy Pratt, Charles Bostian, Jeremy Allnutt, Satellite Communications, 2nd Edition, Wiley India Pvt. Ltd , 2017, ISBN: 978-81-265-0833-4

ELH – 3.1: ADVANCED DIGITAL COMMUNICATION

Course objectives: To learn digital modulation techniques, power spectra and ISI. To study convolutional coding and decoding for channel coding. To understand Communication through band limited linear filter channels and synchronization. To study Spread spectrum digital communication. To learn fading multipath channels in digital communication.

UNIT – I 20 hrs

Digital modulation techniques: Digital modulation formats, Coherent binary modulation techniques, Coherent quadrature – modulation techniques, Non-coherent binary modulation techniques, Comparison of binary and quaternary modulation techniques, M-ray modulation techniques, Power spectra, Bandwidth efficiency, M-array modulation formats viewed in the light of the channel capacity theorem, Effect of inter symbol interference, Bit verses symbol error probabilities, Synchronization, Applications.

UNIT – II 20 hrs

Coding techniques: Convolutional encoding, Convolutional encoder representation, Formulation of the convolutional decoding problem, Properties of convolutional codes: Distance property of convolutional codes, Systematic and nonsystematic convolutional codes, Performance Bounds for convolutional codes, Coding gain, Other convolutional decoding algorithms, Sequential decoding, Feedback decoding, Turbo codes.

UNIT- III 20 hrs

Communication through band limited linear filter channels: Optimum receiver for channel with ISI and AWGN, Linear equalization, Decision - feedback equalization, Reduced complexity ML detectors, Iterative equalization and decoding - Turbo equalization. Adaptive equalization: Adaptive linear equalizer, adaptive decision feedback equalizer, Adaptive equalization of Trellis - coded signals, Recursive least square algorithms for adaptive equalization, Self-recovering (blind) equalization. Spread spectrum signals for digital communication: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, Frequency hopped spread spectrum signals, CDMA, Time hopping SS, Synchronization of SS systems.

TEXT BOOK:

1. John G. Proakis and Masoud Salehi, ―Digital Communications‖, Tata McGraw-Hill, 5th Edition, 2014.
2. Simon Haykin, ―Digital Communications‖, John Wiley India Pvt., Ltd, 2008.
3. Digital Commuication Fundamentals and Applications, Bernard SKLAR, 2nd Edition

REFERENCE BOOKS:

1. K. Sam Shanmugam, ―Digital and Analog Communication Systems‖, John Wiley India Pvt. Ltd., 2012.
2. Simon Haykin, ―An introduction to Analog and Digital Communication‖, John Wiley India Pvt. Ltd., 2006.
3. Bernard Sklar, ―Digital communications‖, Pearson education, 2009.

ELH – 3.2 ADVANCED COMPUTER NETWORKS

Course Objectives: To study the various Telephone networks, multiplexing techniques and Access systems. To study the different LANs. To understand concepts of Scheduling schemes and ATM network protocols and their addressing routing. To Study of various network protocols and traffic management models. To Analyze problems in various modelling methods in networks and different routing algorithms

UNIT-I **20 hrs**

Introduction: Protocols and standards: Definition and Uses of Computer Network, Classification of Computer network, Network Architecture, Internet Standards, Internet Administration; Overview of reference models: The OSI model, The OSI Reference Model, TCP/IP protocol Suite, The TCP/IP Reference Model, Comparison of the OSI & the TCP/IP Reference Models, Addressing, IP versions. Connectors, Transceivers and Media converters, Network interface cards and PC cards, Repeaters, Hubs, Bridges, Switches, Routers and Gateways etc. H/W selection. , Telephone networks, networking principles.

Packet Switching Protocol: X.25, theory of Operation and Network Layer functions, X.75, Internetworking protocols, SMDS, Subscriber Interface and Access Protocol, Addressing and Traffic Control Common Protocols and interfaces in upper Layer: TCP/IP suite, Network Layer, Transport Layer, Applications Layer, Addressing and routing design, Socket programming

UNIT-II **20 hrs**

Multiplexing and Local area networks: Multiplexing, Types of Multiplexing- FDM, TDM, SM; - Ethernet, token ring, FDDI; switching - circuit switching, packet switching, multicasting.Optical Networking: SONET/SDH standards, Dense Wavelength division multiplexing (DWDM), Performance and design Considerations Integrated Service Digital Network: History of Analog and Digital Network - Access to ISDN - ISDN Layers - Broadband ISDN - X.25 Layers - Packet Layer

Protocol. Internet protocols: Internet basics, IP, TCP, UDP, ICMP, HTTP; World Wide Web (WWW), Security in Internet, E-mail Security.

UNIT-III **20 hrs**

ATM: The WAN Protocol: Faces of ATM, ATM Protocol operations (ATM cell and Transmission) ATM Networking basics, Theory of Operations, B-ISDN reference model, PHY layer, ATM Layer (Protocol model), ATM layer and cell, Traffic Descriptor and parameters, Traffic Congestion control defined, AAL Protocol model, Traffic contract and QoS, User Plane overview, Control Plane AAL, Management Plane, Sub-DS3 ATM, ATM public services.

Network Management: SNMP: Concept, Management Components, SMI, MIB, SNMP format, Messages. Network Security: Cryptography, Symmetric Key Algorithms, Public Key Algorithms, Digital Signatures, Management of Public Keys, Communication Security, And Web Security, Web security and Traffic Management Basics: Introduction, Web Security Requirements, Secure Socket Layer (SSL), Traffic Management, Quality characteristics and requirements Quality of Service and Queue Analysis:

Text Books:

1.Advance Computer Network Author: Dayanand Ambawade, Dr. Deven shah, Prof. Mahendra

Mehra Wiley India

REFERENCE BOOKS/WEBLINKS:

1. S Keshav, ―An Engineering approach to Computer Networking‖, Pearson Education, 1997.
2. A Leon-Garcia, and I Widjaja, "Communication Network: Fundamental Concepts and Key Architectures", Tata McGraw-Hill, 2000.
3. J F Kurose, and K W Ross, "Computer Networking: A top down approach featuring the Internet", Pearson Education, 2001.

ELH – 3.3: IMAGE PROCESSING

Course Objective: Develop an overview of the field of image processing. Understand the fundamental algorithms and how to implement them. Prepare to read the current image processing research literature. Gain experience in applying image processing algorithms to real problems.

Unit I **20 hrs**

Introduction and Digital Image fundamentals: Introduction to Digital Image Processing, Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Mathematical tools used in DIP. Intensity Transformations and Spatial Filtering: Some basic intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Combining Spatial Enhancement Methods.

Unit II **20 hrs**

Filtering in Frequency Domain: Preliminary concepts, Sampling, Fourier Transform of sampled Functions, DFT of two variables, Properties of 2D DFT, Basics of Filtering in the Frequency Domain, Image Smoothing using Frequency-Domain Filters, Image Sharpening using Frequency Domain Filters, Selective Filtering. Image Restoration and Reconstruction: Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear Position-Invariant.

Unit III **20 hrs**

Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, the Hit or Miss Transformation, Basic Morphological Algorithms, Gray Scale Morphology. Image Segmentation: Fundamentals, Point, Line and Edge Detection, Thresholding, Region-Based

Segmentation. Color Image Processing: Color Fundamentals, Color Models, Pseudo-color Image Processing, Full-Color Image Processing, Color Transformations, Smoothing and Sharpening,

Books:

1. "Digital Image Processing", Rafael Gonzalez and Richard Woods, PHI.2nd Edition.
2. "Fundamentals of Digital Image Processing", A. K. Jain, Prentice Hall of India, 1989.
3. "Digital Image Processing", W. K. Pratt, Prentice Hall, 1989.

ELS-3.4.1: INFORMATION THEORY & CODING

Course Objectives: In this unit students will acquire knowledge about information and entropy, source coding, Huffman code etc. Hamming weight, minimum distance decoding and different types of codes. They also learn about syndrome calculation and design of an encoder and decoder.

UNIT-I **20 hrs**

INFORMATION THEORY – Measure of information, Average information content of symbols in long independent sequences, Average information content of symbols in long dependent sequences. Mark-off statistical model for information source, entropy and information rate of mark-off source,

SOURCE CODING - Encoding of source output, Shannon's encoding algorithm, Communication channels, Source coding theorem, Huffman coding, Discrete memoryless channels, Mutual information, channel capacity. Channel coding theorem, Differential entropy and mutual information for continuous ensembles, Channel capacity theorem.

UNIT-II **20 hrs**

ERROR CONTROL CODING: BLOCK CODEs – Introduction, Types of errors, examples, Types of codes, Definitions and Principles: Hamming weight, hamming distance, Minimum distance decoding - Single parity codes, Hamming codes, Repetition codes - Linear block codes, Matrix description, error detection and correction, standard arrays and table lookup for decoding.

UNIT – III **20 hrs**

Binary cyclic codes, Algebraic structures of cyclic codes, Encoding using an (n-k) bit shift register, Syndrome calculation, BCH codes.

RS codes, Goley Codes, shortened cyclic codes, burst error correcting codes, Burst and Random error correcting codes.

Convolution Codes, Time domain approach, Transform domain Approximation.

TEXT BOOKS:

1. Digital and Analog Communication systems, K Sam Shanmugam
2. Information theory and coding, Giridhar

REFERENCE BOOKS:

1. ITC and Cryptography, Ranjan Bose, TMH, II edition, 2007
2. Digital Communications – Glover and Granti 2nd Edition, 2008
3. Information theory & Coding – J S Chitode, Technical publications 2009.

ELS – 3.4.2: MULTIMEDIA

Course objectives: This course will enable students to • Define the Multimedia Communication Models • Explain Multimedia Transport in Wireless Networks • Solve the Security issues in multimedia networks • Illustrate real-time multimedia network applications. • Explain different network layer based application

UNIT-1 **20 hrs**

Introduction, multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology, network QoS and application QoS, Digitization principles, Text, images, audio and video.

UNIT-II **20 hrs**

Text and image compression, compression principles, text compression- Runlength, Huffman, LZW, Document Image compression using T2 and T3 coding, image compression- GIF, TIFF and JPEG Audio and video compression, audio compression – principles, DPCM, ADPCM, Adaptive and Linear predictive coding, Code-Excited LPC, Perceptual coding, MPEG and Dolby coders video compression, video compression principles.

UNIT-III **20 hrs**

Video compression standards: H.261, H.263, MPEG, MPEG 1, MPEG 2, MPEG-4 and Reversible VLCs, MPEG 7 standardization process of multimedia content description, MPEG 21 multimedia framework. Notion of synchronization, presentation requirements, reference model for

synchronization, Introduction to SMIL, Multimedia operating systems, Resource management, process management techniques.

TEXT BOOKS:

1. Fred Hassall, "Multimedia Communications", Pearson education, 2001.
2. Raif Steinmetz, Klara Nahrstedt, "Multimedia: Computing, Communications and Applications", Pearson education, 2002.

REFERENCE BOOKS:

1. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, "Multimedia Communication Systems", Pearson education, 2004.
2. John Billamil, Louis Molina, "Multimedia : An Introduction", PHI, 2002.

ELE 3.5 FUNDAMENTALS OF DIGITAL ELECTRONICS

UNIT I **12 hrs**

Binary Systems: Digital Computers and Digital Systems, binary numbers, number based conversion, Octal and Hexa decimal Numbers, complements, binary codes, binary storage and registers, binary logic, integrated circuits

Boolean Algebra and Logic Gates: Basic definitions, Axiomatic definition of Boolean algebra, basic theorems and properties of Boolean algebra, Boolean functions, canonical and standard forms, the map method of simplification of Boolean functions. Two-Three-Four-Five-Six variable maps, product of Sum simplification, NAND and NOR implementation, don't care conditions, The Tabulation Method, determination and selection of prime implicants

UNIT II **12 hrs**

Combinational logic: Introduction, design procedure, adders, binary parallel adder, decimal adder, Subtractor, Code conversion, magnitude Comparators, decoders and multiplexers.

Sequential Logic: Introduction, Flip Flops, Types-SR, JK, D & T, Triggering of Flip Flops, Analysis of Clocked sequential circuits, State reduction and assignment, Flip flop excitation tables, design procedure, shift registers and counters

TEXT BOOKS:

1.M. Morris Mono, Digital Logic and Computer Design, PHI, 2002

2.Floyd T L "Digital Fundamentals", 7th edn. (Pearson Education Asia), 2002

REFERENCE BOOKS:

A P Malvino and D P Leach, Digital Principles and Applications, TaTa McGraw Hill, 4th edition, 1998

ELH – 4.1: VLSI Design

Course Objectives: The objectives of the course is to enable students to: Impart knowledge of MOS transistor theory and CMOS technologies, Impart knowledge on architectural choices and performance tradeoffs, involved in designing and realizing the circuits in CMOS technology, Cultivate the concepts of subsystem design processes, Demonstrate the concepts of CMOS testing.

UNIT – I **20 hrs**

MOS Transistor Theory: n MOS / p MOS transistor, threshold voltage equation, body effect, MOS device design equation, sub threshold region, Channel length modulation. Mobility variation, Tunneling, punch through, hot electron effect MOS models, small signal AC Characteristics, CMOS inverter, βn / βp ratio, noise margin, static load MOS inverters, differential inverter, tristate inverter, BiCMOS inverter.

UNIT-II **20 hrs**

CMOS Process Technology: Semiconductor Technology overview, basic CMOS technology, p well / n well / twin well process. Current CMOS enhancement (oxide isolation, LDD, refractory gate, multilayer inter connect), Circuit elements, resistor, capacitor, interconnects, MOS mask layer, stick diagram, design rules and layout, symbolic diagram, mask feints, scaling of MOS circuits. Basics of Digital CMOS Design: Combinational MOS Logic Circuits-Introduction, CMOS logic circuits with a MOS load, CMOS logic circuits, complex logic circuits, CMOS full adder, Transmission Gate. Sequential MOS logic Circuits – Introduction, Behavior of bi-stable elements, SR latch Circuit, clocked latch and Flip Flop Circuits, CMOS D latch and edge triggered Flip Flop.

UNIT-III **20 hrs**

Dynamic Logic Circuits – Introduction, principles of pass transistor circuits, Voltage boot strapping synchronous dynamic circuits techniques, Dynamic CMOS circuit techniques Sheet resistance & standard unit capacitance concepts, delay unit time, inverter delays, driving capacitive loads, propagate delays. Dynamic CMOS and clocking: Introduction, advantages of CMOS over NMOS, CMOS\SOS technology, CMOS\bulk technology, latch up in bulk CMOS., Domino CMOS structure and design, Charge sharing, Clocking- clock generation, clock distribution, clocked storage elements.

Reference Books:

1. Neil Weste and K. Eshragian, "Principles of CMOS VLSI Design: A System Perspective", Pearson Education (Asia) Pvt. Ltd., 2nd Edition ,2000.
2. Wayne Wolf, "Modern VLSI design: System on Silicon" Pearson Education, Second Edition, 1998
3. Douglas A Pucknell & Kamran Eshragian, "Basic VLSI Design" PHI 3rd Edition (original Edition – 1994)
4. Sung Mo Kang & Yosuf Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design", McGraw- Hill, 3rd Edison, 2003.

ELH -4.2: MACHINE LEARNING

Course Outcomes: After studying this course, students will be able to Identify the problems for machine learning. And select the either supervised, unsupervised or reinforcement learning. Explain theory of probability and statistics related to machine learning Investigate concept learning, ANN, Bayes classifier, k nearest neighbor, Q,

UNIT –I **20 hrs**

Introduction: Well posed learning problems, Designing a Learning system, Perspective and Issues in Machine Learning. Concept Learning: Concept learning task, Concept learning as search, Find-S algorithm, Version space, Candidate Elimination algorithm, Inductive Bias. Decision Tree Learning: Decision tree representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning.

UNIT –II **20 hrs**

Artificial Neural Networks: Introduction, Neural Network representation, Appropriate problems, Perceptrons, Backpropagation algorithm.

Bayesian Learning: Introduction, Bayes theorem, Bayes theorem and concept learning, ML and LS error hypothesis, ML for predicting probabilities, MDL principle, Naive Bayes classifier, Bayesian belief networks, EM algorithm

UNIT –III **20 hrs**

Evaluating Hypothesis: Motivation, estimating hypothesis accuracy, Basics of sampling theorem, General approach for deriving confidence intervals, Difference in error of two hypotheses, Comparing learning algorithms.

Instance Based Learning: Introduction, k-nearest neighbor learning, locally weighted regression, radial basis function, cased-based reasoning,

Reinforcement Learning: Introduction, Learning Task, Q Learning

Text Books:

1. Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education.

Reference Books:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, h The Elements of Statistical Learning, 2nd edition, springer series in statistics.
2. Ethem Alpaydın, Introduction to machine learning, second edition, MIT press.

ELH – 4.3: EMBEDDED SYSTEMS

Course Objectives: To expose the students to the fundamentals of embedded system design. To study in Hardware Software Co-Design. To design and develop embedded hardware and firmware. To study the Cortex M3 Programming, Exceptions Programming, Advanced Programming Features. To impart knowledge on ARM Cortex-M3 to enable students to acquire more awareness on real time embedded applications.

UNIT – I **20hrs**

Typical Embedded System: Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other System Component, Characteristics and Quality Attributes of Embedded Systems. Hardware Software Co-Design and Program Modeling: Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modeling Language, Hardware Software Trade-offs.

UNIT – II **20 hrs**

Embedded Hardware, Firmware Design and Development: EDA Tools, how to Use EDA Tool, Schematic Design – Place wire, Bus, port, junction, creating part numbers, Design Rules check, Bill of materials, Netlist creation, PCB Layout Design – Building blocks, Component placement, PCB track routing. Embedded Firmware Design Approaches and Embedded Firmware Development Languages.

UNIT – III **20 hrs**

ARM- 32-bit Microcontroller family: Cortex M3 Basics Architecture of ARM Cortex-M3, Operation modes and states, Registers, Special Registers, Data type, Memory format, Instruction Set Summary. ARM-32-bit Microcontroller family: Interrupt Controllers, Exceptions and Programming: Nested Vector Interrupt Controller, Interrupt behavior of ARM Cortex-M3, Cortex M3 Programming, Exceptions Programming, Advanced Programming Features and Memory Protection unit.

The Embedded System Development Environment: The Integrated Development Environment (IDE), Types of Files Generated on Cross compilation, Disassembler/ Decompiler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan, Case studies.

Text Books / References:

1. Shibu K V, ―Introduction to Embedded Systems‖, Tata McGraw Hill Education Private Limited, 2009
2. Cortex M3 Technical Reference Manual, by ARM.
3. James K Peckol, ―Embedded Systems – A contemporary Design Tool‖, John Weily, 2008.

ELH – 4.4: PATERN RECOGNITION

Course objectives: To introduce the fundamental algorithms for pattern recognition. To instigate the various classification and clustering techniques. Students will be able to Design and construct a pattern recognition system. Know the major approaches in statistical and syntactic pattern recognition. Become aware of the theoretical issues involved in pattern recognition system design such as the curse of dimensionality. Implement pattern recognition techniques instigate the various classification and clustering techniques

UNIT – I **20 hrs**

Introduction: Basics of pattern recognition system, various applications, Machine Perception, classification of pattern recognition systems Design of Pattern recognition system, Pattern recognition Life Cycle Statistical Pattern Recognition: Review of probability theory, Gaussian distribution, Bayes decision theory and Classifiers, Optimal solutions for minimum error and minimum risk criteria, Normal density and discriminant functions, Decision surfaces Parameter estimation methods: Maximum-Likelihood estimation, Expectation-maximization method, Bayesian parameter estimation

UNIT – II **20 hrs**

Concept of feature extraction and dimensionality, Curse of dimensionality, Dimension reduction methods - Fisher discriminant analysis, Principal component analysis Hidden Markov Models (HMM) basic concepts, Gaussian mixture models. Non-Parameter methods: Non-parametric techniques for density estimation - Parzen-window method, K-Nearest Neighbour method. Non-metric methods for pattern classification: Non-numeric data or 15% nominal data

UNIT – III **20 hrs**

Decision trees: Concept of construction, splitting of nodes, choosing of attributes, overfitting, pruning. Linear Discriminant based algorithm: Perceptron, Support Vector. Machines Multilayer perceptron, Back Propagation algorithm, Artificial. Neural networks Classifier Ensembles: Bagging, Boosting /

Ada Boost Unsupervised learning: Clustering - Criterion functions for clustering, Algorithms for clustering: K-means and Hierarchical methods, Cluster validation

Text Books

1. C M Bishop, Pattern Recognition and Machine Learning, Springer
2. R O Duda, P.E. Hart and D.G. Stork, Pattern Classification and scene analysis, John Wiley

References

1. Morton Nadier and Eric Smith P., Pattern Recognition Engineering, John Wiley & Sons, New York, 1993.
2. Robert J. Schalkoff, Pattern Recognition : Statistical, Structural and Neural Approaches, John Wiley & Sons Inc., New York, 2007.
3. S.Theodoridis and K. Koutroumbas, Pattern Recognition, 4/e, Academic Press, 2009.
4. Tom Mitchell, Machine Learning, McGraw-Hill
5. Tou and Gonzales, Pattern Recognition Principles, Wesley Publication Company, London, 1974.