Ph.D. Course work

Pre-Ph.D. Examination Syllabus

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING
KONERU LAKSHMAIAH EDUCATION FOUDATION
VADDESWARAM - 522302, ANDHRA PRADESH, INDIA.

List of Pre-Ph.D Courses

L-T-P-S: 3-0-0-0

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

S.No	Paper 1	Subject Code
1	RESEARCH METHODOLOGY	25RES104

S.N	Code	PAPER – 2	Code	PAPER – 3
1.	25EC201	Global Positioning Systems	25EC301	Bio Medical signal Processing
2.	25EC202	Machine Learning	25EC302	Advanced Embedded Processor Architecture
3.	25EC203	Embedded Networking	25EC303	Wireless Cellular Communications
4.	25EC204	Modern Digital Communication	25EC304	Natural Language Processing
5.	25EC205	SOFT COMPUTING	25EC305	Advanced Computational Mathematics
6.	25EC206	Digital Video Processing	25EC306	EMI/EMC
7.	25EC207	Radiating systems	25EC307	MEMS Measurement Techniques
8.	25EC208	Micro Electro Mechanical Systems	25EC308	Antenna Measurements
9.	25EC209	RF & Microwave System Design	25EC309	VLSI System Design
10.	25EC210	Low Power VLSI Circuits	25EC310	MOS Circuit Design
11.	25EC211	Detection and Estimation Of Signals	25EC311	Testing of VLSI Circuits
12.	25EC212	Adaptive Signal Processing	25EC312	Advanced Analog IC Design
13.	25EC213	Real Time Concepts for Embedded Systems	25EC313	Microwave and Millimeter wave Circuits
14.	25EC214	Image Processing and Computer Vision	25EC314	Pattern Recognition
15.	25EC215	ASIC AND FPGA DESIGN	25EC315	CMOS RF Circuit Design
16.	25EC216	Principles of Nanotechnology and Nanofabrication	25EC316	Image And Video Processing
17.	25EC217	5G NR - Next Generation Wireless Technologies	25EC317	Nanoscale Engineering for Clean Energy

RESEARCH METHODOLOGY **Code: 25 RES 101**

[COMMON TO ALL ENGINEERING STREAMS INCLUDING BIOTECH & MCA]

UNIT I

Introduction: Definition and Objectives of Engineering Research, and Motivation in Engineering Research – Types of Engineering Research, Finding and Solving a Worthwhile Problem, Various Steps in Research process, Mathematical tools for analysis, Developing a research question-Choice of a problem Literature review, Surveying, synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code. Reproducibility and replicability in research, FAIR data principles, open science practices

UNIT II

Quantitative Methods for problem solving:

Statistical Modeling and Analysis: Sampling, Characteristics of a good sample. Probability Sample, Simple Random Sample, Systematic Sample, Stratified Random Sample, Multistage sampling. Determining size of the sample, Practical considerations in sampling and sample size. Probability Distributions, Fundamentals of Statistical Analysis and Inference, Bayesian inference, Concepts of Correlation and Regression, Multivariate methods Fundamentals of Time Series Analysis and Spectral Analysis, Error Analysis, Applications of Spectral Analysis

UNIT III

Tabular and graphical description of data: Tables and graphs of frequency data of one variable, Tables and graphs that show the relationship between two variables, Relation between frequency distributions and other graphs, preparing data for analysis, Data Cleaning and Validation, Data Transformation and Feature Engineering, Interactive and Dynamic Visualizations

UNIT IV

Soft Computing: Computer and its role in research, Use of statistical software SPSS, GRETL etc in research. Introduction to evolutionary algorithms - Fundamentals of Genetic algorithms, Simulated Annealing, Neural Network based optimization, Optimization of fuzzy systems.

UNIT V

Structure and Components of Research Report, Types of Report, Layout of Research Report using Latex, Mechanism of writing a research report, referencing in academic writing. Abstracting, Bibliography.

Text Books

1. C.R. Kothari, Research Methodology Methods and Techniques, 2/e, Vishwa Prakashan, 2006
2. Donald H.McBurney, Research Methods, 5th Edition, Thomson Learning, ISBN:81-315-0047-0,2006

Reference Books

1. Donald R. Cooper, Pamela S. Schindler, Business Research Methods, 8/e, Tata McGraw-Hill Co. Ltd., 2006.
2. Fuzzy Logic with Engg Applications, Timothy J.Ross, Wiley Publications, 2nd Ed[d]
3. Simulated Annealing: Theory and Applications (Mathematics and Its Applications, by P.J. van Laarhoven & E.H. Aarts[e]
4. Genetic Algorithms in Search, Optimization, and Machine Learning by David E. Goldberg

Paper 2

Course Name: Global Positioning Systems **Course Code: 25 EC201**

Syllabus

GPS fundamentals: INS, Trilaiteration, Hyperbolic navigation, Transit, GPS principle of operation, architecture, operating frequencies, orbits, Keplerian elements. Solar and Siderial days, GPS and UTC Time

GPS Signals:, Signal structure, C/A and P-Code, ECEF and ECI coordinate systems and WGS 84 and Indian datums, Important components of receiver and specifications, link budget.

GPS Error Models: Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, Antenna Phase center variation, multipath; estimation of Total Electron Content (TEC) using dual frequency measurements, Various DOPs, UERE. Spoofing and Anti-spoofing. : Future GPS satellites, new signals and their benefits GPS integration – GPS/GIS, GPS/INS, GPS/pseudolite, GPS/cellular.

GPS data processing, DGPS and Applications: RINEX Navigation and Observation formats, Code and carrier phase observables, linear combination and derived observables, Ambiguity resolution, cycle slips, Position estimation. principle of operation of DGPS, architecture and errors.

Other Constellations and Augmentation systems Other satellite navigation constellations GLONASS and Galileo IRNS System. : Relative advantages of SBAS and GBAS, Wide area augmentation system (WAAS) architecture, GAGAN, EGNOS and MSAS. Local area augmentation system (LAAS) concept.

Reference Books:

1. B.HofmannWollenhof, H.Lichtenegger, and J.Collins, "GPS Theory and Practice", Springer Wien, new York,2000.
2. Pratap Misra and Per Enge, "Global Positioning System Signals, Measurements, and Performance," Ganga-Jamuna Press, Massachusetts,2001.
3. Ahmed El-Rabbany, "Introduction to GPS," Artech House, Boston, 2002. WITH EFFECT FROM THE ACADEMIC YEAR2010-2011
4. Bradford W. Parkinson and James J. Spilker, "Global Positioning System: Theory and Applications," Volume II, American Institute of Aeronautics and Astronautics, Inc., Washington,1996.

Paper 2

Course Name: Machine Learning **Course Code: 25 EC202**

Syllabus

Introduction to Machine Learning, Probability Theory, Model Selection, The Curse of Dimensionality, Decision Theory, Information Theory

Probability Distributions: Binary Variables, Multinomial Variables, The Gaussian distribution, The Exponential Family, Nonparametric Methods

Linear Models for Regression: Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison, The Evidence Approximation, Limitations of Fixed Basis Functions

Linear Models for Classification: Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models, The Laplace Approximation, Bayesian Logistic Regression, Neural Networks and Kernel Methods

TEXTBOOK:

Christopher M. Bishop. 2006. Pattern Recognition and Machine Learning (Information Science and Statistics). Springer-Verlag New York, Inc., Secaucus, NJ, USA.

Paper 2

Course Name: Embedded Networking **Course Code: 25 EC203**

Syllabus

EMBEDDED COMMUNICATION PROTOCOLS: Embedded Networking: Introduction – Serial/Parallel Communication – Serial communication protocols -RS232 standard –RS485 – Synchronous Serial Protocols -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) – PC Parallel port programming -ISA/PCI Bus protocols –Firewire.

USB Bus: Introduction – Speed communication: Packets –Data Microcontroller USB Interface, Identification on the bus – USB States – USB bus flow types –Enumeration –Descriptors –PIC 18

CAN Bus: Introduction - Frames –Bit stuffing –Types of errors –Nominal Bit Timing – PIC microcontroller CAN Interface –A simple application with CAN.

EMBEDDED ETHERNET: Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure.

WIRELESS EMBEDDED NETWORKING: Wireless sensor networks – Introduction – Applications – Network Topology – Localization –Time Synchronization - Energy efficient MAC protocols –SMAC – Energy efficient and robust routing – Data Centric routing.

TEXT BOOKS

1. Frank Vahid, Givargis 'Embedded Systems Design: A Unified Hardware/Software. Introduction', Wiley Publications
2. Jan Axelson, 'Parallel Port Complete', Penram publications.
3. Dogan Ibrahim, 'Advanced PIC microcontroller projects in C', Elsevier 2008
4. Jan Axelson 'Embedded Ethernet and Internet Complete', Penram publications
5. Bhaskar Krishnamachari, 'Networking wireless sensors', Cambridge press 2005.

Paper 2

Course Name: Modern Digital Communication **Course Code: 25 EC204**

Syllabus

Modern Digital Modulation Techniques: Introduction, Information Capacity, Bits, Bit Rate, Baud rate & M-ary Encoding, ASK, FSK, PSK QAM Bandwidth Efficiency Carrier Recovery, Clock Recovery, DPSK, Trellis Code Modulation, Probability of Error & Bit Error Rate, Error Performance.

Baseband Data Transmission: Introduction – Baseband Binary PAM Systems – Baseband Pulse Shaping, Optimum Transmitting and Receiving Filters – Duobinary Baseband PAM System – Use of Controlled ISI in Duobinary Signaling Schemes, Transmitting and Receiving Filters for Optimum Performance.

M-ary Signaling Schemes – Analysis and Design of M-ary Signaling Schemes, Binary Versus M-ary Signaling Schemes - Shaping of the Transmitted Signal Spectrum – Effect of Pre coding on the Spectrum, Pulse Shaping by Digital Methods - Equalization - Transversal Equalizer, Automatic Equalizers.

Block and Convolutional Channel Codes: Linear Block Codes - The Generator Matrix and Parity Check Matrix, Cyclic Codes, Bounds on Minimum Distance of Linear Block Codes, Non Binary Block Codes – Convolutional Codes – Transfer Function of a Convolutional Code, Optimum Decoding of Convolutional Code –Distance Properties of Binary Convolutional Codes.

Spread Spectrum Signals for Digital Communication: Model of Spread Spectrum Digital Communication System – Direct Sequence Spread Spectrum Signals – Error Rate Performance of the Decoder, Some Applications of DS Spread Spectrum Signals, Generation of PN Sequences – Frequency Hopped Spread Spectrum Signals – Performance of FH Spread Spectrum Signals in an AWGN Channel, CDMA System Based on FH Spread Spectrum.

Signals Emerging Digital Communication Technologies.: The North American Hierarchy, Digital Services, Broad band Digital Communication: SONET, Digital Switching Technologies, Broadband Services for Entertainment and Home office Applications, Video Compression, High Definition Television(HDTV)

TEXT BOOKS

1. Advanced Electronic Communications Systems, by Wayne Tomasi, 6 Edition Pearson Education.
2. K Sam Shanmugam, Digital and Analog Communication Systems, John Wiley and sons (Asia) PvtLtd.

REFERENCES

1. Simon Haykin, Digital communications, John Wiley and sons,1998.

2. Wayne Tomasi, Advanced electronic communication systems, 4th Edition Pearson Education Asia,1998
3. B.P.Lathi Modern digital and analog communication systems, 3rd Edition, Oxford Universitypress
4. Ravindranathan” Communication Systems Modeling Using Matlab & Simulink” Universities Press.

Paper 2

Course Name: SOFT COMPUTING **Course Code: 25 EC205**

Syllabus

Foundation of Evolutionary theory, Evolutionary Strategies, Evolutionary programming, Evolutionary Algorithms, Evolutionary Algorithm Case Study, Genetic Algorithm, Genetic Representations, Initial Population, Fitness Function, Selection and Reproduction,

Genetic Operators (Selection, Crossover, Mutation), Artificial Immune Systems, Other Algorithms Harmony Search, Honey-Bee Optimization, Memetic Algorithms, Co-evolution, MultiObjective Optimization, Artificial Life, Constraint Handling

Neural Networks: Neuron Models, Neuron Architecture, Mathematical Model of Neural Networks, Artificial Neural Network Learning Methods and Learning Strategies, Supervised Learning, Unsupervised Learning, Reinforcement Learning, Activation Functions, Pattern Classification and Linear Separability, Single and Multilayer Perceptron Network, SelfOrganizing Map (Kohonen network), Hopfield Network, Back Propagation Network, Radial Basis function Network

Collective Behavior and Swarm Intelligence, Particle Swarm Optimization and Ant Colony Optimization, Artificial evolution of Competing Systems, Artificial Evolution of cooperation and competition. Recent topics from research papers.

Introduction to Neuro-Fuzzy and soft computing: computing constituents and conventions, characteristics. Fuzzy set theory: basic definitions and terminology, settheoretic operations, Mf formulation and parameteization. Fuzzy rules and reasoning: extension principles and fuzzy relations, fuzzy if-then rules, fuzzy reasoning. Fuzzy inference systems: mamdani fuzzy models, sugeno fuzzy models, Tsukamoto fuzzy models, other considerations.

TEXTBOOK:

- Dario Floreano, Claudio Mattiussi, “Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies”, MIT Press, 2008.
- Eberhart, E. and Y. Shi., “Coputational Intelligence: Concepts and Implementations”, Morgan Kauffmann, San Diego, 2007.

Paper 2

Course Name: Digital Video Processing **Course Code: 25 EC206**

Syllabus

Basic steps of Video Processing: Analog Video, Digital Video, Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations.

Motion Estimation: Optical flow, General Methodologies, Pixel Based Motion Estimation, Block- Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation, Application of 2D motion estimation, Parametric motion models.

Optical Flow methods, Motion-compensated filtering, Video processing operations including noise reduction, restoration, super resolution, de-interlacing and video sampling structure conversion, and compression (frame-based and object-based methods), Video quality assessments.

Video segmentation, motion segmentation, tracking, optimization Topics from latest research papers.

Paper 2

Course Name: Radiating systems **Course Code: 25 EC207**

Syllabus

Basics Concepts Of Radiation: Radiation from surface current and current line current distribution, Basic antenna parameters, Radiation mechanism-Current distribution of Antennas, Impedance concept-Balanced to Unbalanced transformer.

Radiation from Apertures Field equivalence principle, Rectangular and circular apertures, Uniform distribution on an infinite ground plane, Aperture fields of Horn antenna-Babinets principle, Geometrical theory of diffraction, Reflector antennas, and Design considerations - Slot antennas.

Synthesis of Array AntennasTypes of linear arrays, current distribution in linear arrays, Phased arrays, Optimization of Array patterns, Continuous aperture sources, Antenna synthesis techniques.

Micro Strip Antennas Radiation mechanisms, Feeding structure, Rectangular patch, Circular patch, Ring antenna. Input impedance of patch antenna, Micro-strip dipole, Micro- striparrays.

EMI/EMC/Antenna Measurements: Log periodic, Bi-conical, Log spiral ridge Guide, Multi turn loop, Traveling Wave antenna, Antenna measurement and instrumentation, Amplitude and Phase measurement, Gain, Directivity, Impedance and polarization measurement, Antenna range, Design and Evaluation.

TEXT BOOKS

1. Kraus.J.D.,"Antennas"II Edition, John wiley andSons.
2. Balanis.A, "Antenna Theory Analysis and Design", John Wiley and Sons, NewYork, 1982

REFERENCES

1. RF System Design, Peter Kinget Bell Laboratories, Lucent Technologies MurrayHill,
2. Practical RF system design, Wiley-IEEE, 2003 - Technology &Engineering

Paper 2

Course Name: Micro Electro Mechanical Systems **Course Code: 25 EC208**

Syllabus

Overview of MEMS and Micro Systems: Introduction, miniaturization, Reliability, Advantages of MEMS, working principles of chemical sensors, optical, pressure and thermal sensors, micro actuation: actuation using thermal forces, actuation using piezo electric crystals, actuation using electrostatic forces; micro accelerometers, micro fluidics, MEMS switches, phase shifters, varactors, tunable oscillators

Basics of MEMS technology: Molecular theory of matter and intermolecular forces, doping of semi-conductors, the diffusion process, scaling laws in miniaturization, Engineering mechanics: static bending of thin plates, mechanical vibrations, thermo mechanics, fluid flow in nano scale.

Micro system Design: Introduction, design considerations, process design, mechanical design, micro system packaging, essential packaging technologies, 3D packaging, assembly, selection of materials, Finite Element Analysis (FEA).

Fabrication methods: Lithography: Introduction, wafers, masks, spinning resist and soft baking, exposure and post exposure treatment, resolution, mathematical expression of resist profiles, image reversal, interface effects, radiation and resist profiles, ion implantation, diffusion, oxidation, RIE , Chemical Vapour Deposition (CVD), Physical Vapour Deposition (PVD), deposition by epitaxy, comparison of bulk and surface micromachining, comparison of wet and dry etching, LIGA process. system level packaging, single and multichip packaging.

Case Study: MEMS capacitive switch, MEMS capacitive accelerometer, MEMS pressure sensor, quartz rate gyroscope, cantilever based micro cantilevers for mass measurement.

References:

1. Microsystem Design by *Stephen D.Senturia*, Springer InternationalEdition,2010
2. RF MEMS Theory, Design and Technology by *Gabriel M.Rebeiz,*
Wiley India Pvt Ltd.
3. MEMS and Microsystems: Design and Manufacture by *Tai-Ran Hsu*, Tata McGraw
4. Hill,2002
5. The MEMS Handbook, *Mohamed Gad-el-Hak*, CRC Press, 2002.
6. Foundations of MEMS by *Chang Liu*, Second Edition, PearsonPublication

Paper 2

Course Name: RF & Microwave System Design **Course Code: 25 EC209**

Syllabus

Introduction: Importance of RF and Microwave Concepts and Applications- and Units-Frequency Spectrum, RF and Microwave Circuit Design, Dimensions - RF Behavior of Passive Components: High Frequency Resistors, High Frequency Capacitors, High Frequency Inductors, General Introduction, Types of Transmission Lines-Equivalent Circuit representation.

The Smith Chart: Introduction, Derivation of Smith Chart, Description of two types of smith chart, Z-Y Smith chart, Distributed Circuit Applications, Lumped Element Circuit Applications. SINGLE AND MULTIPORT NETWORKS: Basic Definitions, InterconnectingNetworks.

Scattering Parameters: Scattering Parameters: Definition, Meaning, Chain Scattering Matrix, Conversion between S and Z-parameters, Signal Flow Chart Modeling.

Stability and Gain Considerations – RF Design RF Source, Transducer Power Gain, Additional Power Relations-Stability Considerations: Stability Circles, Unconditional Stability, and Stabilization Methods-Unilateral and Bilateral Design for Constant Gain- Noise Figure Circles-Constant VSWR Circles.

RF Filters, Amplifiers And Oscillators Design Generalization-Basic Resonator and Filter Configurations: Low Pass, High Pass, Band Pass and Band Stop type Filters-Filter Implementation using Unit Element and Kuroda's Identities Transformations. Introduction, Types and Characteristics of Amplifiers, Small Signal Amplifiers, Design of different types of amplifiers (NBA, HGA, MGA, LNA, MNA, BBA), Design of Large Signal Amplifiers Oscillator vs Amplifier Design, Design procedure of TransistorOscillators.

TEXT BOOKS

1. Mathew M. Radmanesh, "Radio Frequency & Microwave Electronics", Pearson Education Asia, SecondEdition,
2. Reinhold Ludwig and Powel Bretchko," RF Circuit Design – Theory and Applications", Pearson Education Asia, FirstEdition.

REFERENCES

1. Joseph. J. Carr, "Secrets of RF Circuit Design", McGraw Hill Publishers, Third Edition.
2. Ulrich L. Rohde and David P. New Kirk, "RF / Microwave Circuit Design", John Wiley & Sons USA,2000.

3. Roland E. Best, “Phase - Locked Loops: Design, simulation and applications”, McGraw Hill Publishers 5TH
4. Devendra K. Misra, “Radio Frequency and Microwave Communication Circuits – Analysis and Design “John Wiley & Sons,Inc.
5. Jon B. Hagen, “Radio Frequency Electronics ", Cambridge university press, Cambridge,1996.
6. James Hardy, “High Frequency Circuit Design ", Resto Publishing Co., NewYork, 1979.
7. Ian Hickman, “RF Handbook ", Butter Worth Heinemann Ltd., Oxford,1993.
8. Ulrich L.Rohde, T.T.N.Bucher, “Communication Receivers ", McGraw-Hill, New York,1998.

Paper 2

Course Name: Low Power VLSI Circuits **Course Code: 25 EC210**

Syllabus

Power Dissipation and CMOS: Sources of power dissipation – Physics of power dissipation in MOSFET devices: The MIS structure, long channel MOSFET, Submicron MOSFET , gate induced drain leakage– Power dissipation in CMOS - short circuit dissipation, dynamic dissipation, load capacitance– Low power VLSI design: Limits – principles of low power design.

Design of Low Power Circuits: Transistor and Gate Sizing - Sizing an Inverter Chain, Transistor and Gate Sizing for Dynamic Power Reduction, Transistor Sizing for Leakage Power Reduction - Network Restructuring and Reorganization - Transistor Network Restructuring, Transistor Network Partitioning and Reorganization - Special Latches and Flip-flops : Self-gating Flip-flop, Varieties of Boolean Functions, Adjustable Device Threshold Voltage.

Low Power Memory Architectures: Organization of a static RAM, MOS Static RAM Memory cell, Banked organization of SRAMs, Reducing voltage swings on bit lines, Reducing power in write driver circuits, Reducing power in sense amplifier circuits, method for achieving low core voltages from a single supply.

Testing of Low Power VLSI Circuits: Circuit Design style, Leakage current in deep submicrometer transistors, Deep submicrometer device design issues, Low voltage circuit design techniques, Designing deep sub-micrometer ICs with elevated intrinsic leakage, multiple supply voltages.

Text Books:

1. K. Roy and S. C. Prasad, Low Power CMOS VLSI Circuit Design, John Wiley and Sons, 3 rd Edition, 2009.

2. Jan Rabaey, Low Power Design Essentials, Springer Publications, 1 st Edition, 2009.

Reference Books:

1. Chandrakasan and R. Brodersen, Low-Power CMOS Design, IEEE Press, 1 st Edition, 1995.

2. Chandrakasan, Bowhill, and Fox, Design of High-Performance Microprocessors, IEEE Press, 1 st Edition, 2000.

Paper 2

Course Name: Detection and Estimation of Signals **Course Code: 25 EC211**

Syllabus

Introduction to Discrete-time signals: Fourier Transform of a discrete time signal, Amplitude and phase spectrum, Frequency content and sampling rates, Transfer function, Frequency response.

Random - Discrete-time signals: Review of probability, Random data, Generation of Pseudo- random noise, Filtered signals, Autocorrelation and power spectral density, Sampling band- Limited random.

Detection of Signals in Noise:- Minimum probability of Error Criterion, Neyman-Person criterion for Radar detection of constant and variable amplitude signals, Matched filters, Optimum formulation, Detection of Random signals, Simple problems thereon with multi sample cases.

Estimation of Signals in Noise: Linear mean squared estimation, Non linear estimates, MAP and ML estimates, Maximum likelihood estimate of parameters of linear system, Simple problems thereon.

Recursive linear mean squared Estimation: Estimation of a signal parameter, Estimation of time-varying signals, Kalman filtering, Filtering signals in noise, Treatment restricted to two variable case only, Simpleproblems.

TEXT BOOKS

1. Signal processing: Discrete Spectral analysis, Detection and Estimation, Mischa Schwartz and Leonard Shaw, Mc-Graw Hill Book Company, 1975.

2. Signal Detection and Estimation, 2nd edition, Mourad Barkat, Artech House Inc, Norwood, MA 02062,2005,

3. Fundamentals of Statistical Signal Processing: Estimation Theory, Steven M. Kay, Prentice Hall New Jersey,1993,

REFERENCE TEXT BOOK

1. “Probability, Random Variables and Random Signal Principles”, Peyton Z.PeeblesJr, 4th Edition, Tata Mc GrawHill.

2. Jerry M. Mendel,Lessons in Estimation Theory for Signal Processing, Communication and Control, Prentice Hall Inc., 1995.

3. Shanmugam and Breipohl, ‘Detection of signals in noise and estimation’, John Wiley & Sons, New York,1985.

Paper 2

Course Name: Adaptive Signal Processing **Course Code: 25 EC212**

Syllabus

Complex-Valued Adaptive Signal Processing: Optimization in the Complex Domain, Widely Linear Adaptive Filtering, Nonlinear Adaptive Filtering with Multilayer Perceptrons, Complex Independent Component Analysis,

Robust Estimation Techniques for Complex-Valued Random Vectors: Statistical Characterization of Complex Random Vectors, Complex Elliptically Symmetric (CES) Distributions, Tools to Compare Estimators, Scatter and Pseudo-Scatter Matrices Array Processing Examples, MVDR Beamformers Based on M-Estimators,

Turbo Equalization: Communication Chain, Turbo Decoder: Overview, Forward-Backward Algorithm, Simplified Algorithm: Interference Canceler, Capacity Analysis, Blind Turbo Equalization, Convergence, Multichannel and Multiuser Settings,
Subspace Tracking for Signal Processing: Linear Algebra Review, Observation Model and Problem Statement, Preliminary Example: Oja's Neuron, Subspace Tracking,, Eigenvectors Tracking, Convergence and Performance Analysis Issues,

Particle Filtering: The Basic Idea, The Choice of Proposal Distribution and Resampling, Some Particle Filtering Methods, Handling Constant Parameters, Rao–Blackwellization, Prediction, Smoothing,

TEXT BOOKS
1. Tu¨layAdalı ,SimonHaykin," Adaptive Signal Processing", John Wiley &Sons

Paper 2

Course Name: Real Time Concepts for Embedded Systems **Course Code: 25 EC213**

Syllabus

Real-Time Operating Systems: Overview- Threads and Tasks, The Kernel, Time Services and Scheduling Mechanisms- Time Services, Scheduling Mechanisms, Other Basic Operating System Functions- Communication and Synchronization, Event Notification and Software Interrupt, Memory Management, I/O and Networking

Model of Real – Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency, Functional Parameters-pre-emptivity of jobs, criticality of jobs, Resource Parameters of Jobs and Parameters of Resources, Scheduling Hierarchy- Scheduler and Schedules, Feasibility, Optimality and Performance Measures.

Classification of Real Time Scheduling Approaches: Clock- Driven Approach, Weighted Round-Robin Approach, Priority- Driven Approach, Dynamic versus Static Systems, Effective Release Times and Deadlines, optimality of the EDF and LST algorithms, Non optimality of the EDF and LST algorithms, Challenges in validating timing constraints in priority –driven systems Off-line versus On-line Scheduling.

Clock-Driven Scheduling : Notations and Assumptions, Static, Timer -Driven Scheduler, General Structure of Cyclic Schedules, Cyclic Executives, Improving the Average Response Time of Aperiodic Jobs, Scheduling Sporadic Jobs-Acceptance test ,EDF Scheduling of accepted jobs and implementation, Pros and Cons of Clock Driven Scheduling.

EMBEDDED LINUX:

Features - Embedded Linux Distributions - Architecture of Embedded Linux - Linux Kernel Architecture – User Space -Root File System - Linux Start-Up Sequence - GNU Cross Platform Tool chain - Porting Traditional RTOS Applications to Linux.

REAL-TIME LINUX:

Linux and Real-Time - Real-Time Programming in Linux - Hard Real-Time Linux - Building and Debugging - Building the Kernel- Integrated Development Environment - Kernel Debuggers - Embedded Drivers - Board support packages - Introduction to C linux.

TEXT BOOKS:

1. Real Time Systems – By Jane W.S.Liu -Low Price Edition , Pearson EducationAsia

2. Real-Time Concepts for Embedded Systems - Qing Li with Caroline Yao published by CMPBooks

Paper 2

Course Name: Image Processing and Computer Vision **Course Code: 25 EC214**

Syllabus

Image enhancement and restoration Image Enhancements: Point processing functions, Piece-wise linear functions, Histogram base methods (histogram equalization, specification and modification), Bit extraction, and other topics. Restoration (in spatial domain): Image restoration and degradation model, Noise types (Gaussian, Rayleigh, Poisson, other) and their pdfs (Probability Distribution Functions), Averaging Filter (Mean Filters (Arithmetic, Geometric & Harmonic), Inverse filtering, Weiner Filter, Tikhonov Regularization, LMMSE filters, constrained least squares filters, Other related optimization problems.

Edge Detection: Mathematical concepts, Operators based on first order derivative (Roberts, Prewitt and Sobel), Laplacian (Second order derivative based edge detection),LOG. Image Segmentation: Thresholding based (Local, Global, Adaptive), Region based (Region split & merge, Region growing), Cluster based (K-means, Fuzz c-means), Contour based (Snakes' method), Graph based (book/literature)

Feature extraction: Spatial Features, Amplitude, Transform based features, Fourier Descriptors (FDs), Histogram based statistical features, Based on statistical moments (e.g., mean, variance, kurtosis, etc), Shape/geometry based features & moment based features(Radii, perimeter, area, compactness, max boundary rectangle, orientation etc.), Texture features (GLCM and texture features, Gabor features), Color features

Object representation and description Boundary representation: Chain codes, Polygon approximations, Signatures, Boundary segments, Skeletons Boundary description: Shape numbers, FDs, Statistical moments Region representation: Data structures used for representing region (quad tree, RLE, projection) Region description: Topological description, Texture, Moments, Principal components

Object recognition a. Patterns & pattern classification b. Recognition based on decision theoretic methods c. Structural methods

TEXTBOOK::

1. Fundamental of image processing by R.C. Gonzalez
2. Digital image processing by A.K. Jain

Paper 2

Course Name: ASIC AND FPGA DESIGN **Course Code: 25 EC215**

Syllabus

Introduction to ASICs: Types of ASICs, Design Flow, Case study, Economics of ASICs, ASIC Cell Libraries, Combinational Logic Cells, Sequential Logic Cells, Data path Logic Cells, I/O Cells.

ASIC Library Design: Library-Cell, Library Architecture, Gate-Array, Standard-Cell, Datapath-Cell Design. Programmable ASICs: The Antifuse, Static RAM, EPROM, and EEPROM Technology. MOS Programmable Logic Device (PLD).

Programmable ASIC Logic and I/O cells: Logic Cells: Actel ACT, Xilinx LCA, Altera FLEX, Altera MAX, AMDs – CPLD (Mach 1 to 5), Cypress FLASH 370. I/O Cells: DC Output, AC Output, DC Input, AC Input, Clock Input, Xilinx I/O Block.

Programmable ASIC Interconnect and Construction: ASIC Interconnect: Actel ACT, Xilinx LCA, Xilinx EPLD, Altera MAX 5000 and 7000, Altera MAX 9000, Altera FLEX. ASIC Construction: Physical Design, FPGA Partitioning, Partitioning Methods, Floorplanning, Placement, Routing.

Textbooks:

1. Michael John Sebastian Smith, "Application Specific Integrated Circuits", Pearson Education,2001. 2. Debaprasad Das, "VLSI Design"

3. Neil H. E. Weste and K. Eshraghian, Principles of CMOS VLSI Design, 2nd Edition, Addison Wesley

Reference Books:

1. Bob Zeidman, "Designing with FPGAs and CPLDs"

2. Stephen Brown and ZvonkoVranesic "Fundamentals of Digital Logic with Verilog Design"

3. Pak K. Chan, Samiha Mourad,"Digital Design Using Field Programmable Gate Array"

Paper 2

Course Name: Principles of Nanotechnology and Nanofabrication **Course Code: 25 EC216**

Syllabus

Definition of a nanosystem – Evolution of nanotechnology - Dimensionality and size dependent phenomena - Nanostructures – Naturally occurring nanomaterials - Nanoscale properties - Magnetic Moment in clusters/Nanoparticles– Thermal activation and superparamagnetic effects, Capacitance in a nanoparticle, Optical properties - Surface Plasmon Resonance, Nanotechnology Initiatives – challenges and future prospects of nanoscience.

Synthesis of Nanomaterials - Chemical processes: Chemical precipitation, Sol-Gel synthesis; Microemulsions synthesis, Hydrothermal, Solvothermal synthesis, Microwave assisted synthesis; Sonochemical assisted synthesis Physical Process: Inert gas condensation, RF- plasma, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxy (MBE), Chemical vapour deposition (CVD) method.

Physical Properties of Nanostructured Materials: Size effect of Nanomaterials: Size, shape, density, melting point, wet ability and specific surface area. Electrical properties: Electrical conductivity, band gap tuning - band gap determination, Hall effect and its applications. Magnetic properties: Magnetic hysteresis – Superparamagnetism - Optical properties: Photoconductivity, Electroluminescence, Photoluminescence, Jablonski diagram, fluorescence and phosphorescence, Optical properties of nanostructures. Mechanical behavior: Stress – strain behaviour, tensile strength. Thermal properties: Thermal conductivity, thermal expansion and thermal expansion coefficient.

Applications of Nanotechonology - Molecular electronics, nanoelectronics and printed electronics - Linear and nonlinear optical and electro-optical devices - nanomaterials for data storage - Chemical and biosensors – Advanced applications: Solar cells, batteries, supercapacitors. Advanced plasmonic nanoparticles – nano wire – quantum dots application – SPR analysis

Textbooks:

1. M. Wilson, K. Kannangara, G. Smith, M. Simmons, B. Raghuse, "Nanotechnology: Basic Science & Emerging Technologies", Chapman & Hall/CRC, Washington DC, 1stEdition, 2002.
2. C. P. Poole, F. J. Owens, "Introduction to Nanotechnology"John Wiley & Sons, First Edition, New Jersey, 2011.
3. T. Pradeep, "Nano: The essentials- Understanding Nanoscience & Technology" Tata McGraw Hill, New Delhi, 2007.
4. H. S. Nalva, "Nanostructured Materials &Nanotechnology"Academic Press, Tokyo, Concise edition, 2007.
5. R. W. Kelsall, I. W. Hamley, M. Geoghegan, "Nanoscale Science & Technology", John. Wiley & Sons, UK, 1stEdition, 2005.

Paper 2

Course Name: 5G NR - Next Generation Wireless Technologies **Course Code: 25 EC217**

Syllabus

5G New Radio: Historical Trends in Wireless Communications, 1G, 2G, 3G, 4G, Evolution of LTE to Beyond 4G, Introduction to 5G-NR, 5G Road map, Pillars of 5G, 5G use cases-eMMB, mMTC, URLLC, Spectrum of 5G mobile systems, Frequency bands for new radio, New Multicarrier Modulation schemes, (FBMC, GFBM, BFDM, UFMC, and TFP), Waveform Pulses – RRC pulse, PHYDYAS pulse, DC pulse.

Massive MIMO for 5G and Beyond 5G: Introduction to MIMO, Massive MIMO theory-(Downlink, Linear pre-coding schemes, Uplink, Linear detection schemes, Channel estimation), Massive MIMO channels- (Existing conventional MIMO models, Necessary model extensions, MIMO extension of the COST2100 channel model), Beyond 5G-Non orthogonal multiple access (NOMA), Machine type communications, Device to device communications.

Millimeter wave Communications: Millimeter wave characteristics, Development of millimeter wave standards, Modulations of millimeter wave communications- (OOK, PSK, FSK), Millimeter wave link budget, Transceiver Architecture, Millimeter wave antennas- Path Loss, Antenna directivity and Antenna beam width, Advanced diversity over MIMO channels for millimeter wave systems-(Spatial and Temporal diversity, Spatial and Frequency diversity), Preamble design.

Vehicular Communications and other Advanced Topics: Introduction to Vehicular communication, Applications of Vehicular communications- (Safety, Resource efficiency, Infotainment), Communication Regimes- (Bi-directional, position based, Multi hop position based), Architectures for intelligent vehicles- (protocol architectures in communications, architectures for platoon, architectures for sensors). Overview of Cognitive Radio technology in 5G wireless networks, Spectrum optimization using Cognitive Radio, Dynamic spectrum access, Cognitive Radio and Carrier Aggregation, Key requirements, and challenges for 5G Cognitive terminals. RAN architectures for GSM/GPRS, EDGE, UMTS

Textbooks

1. 5G NR: The Next Generation Wireless Access Technology, Erik Dahlman, Stefan Parkvall and Johan Skold, Academic Press, 1 edition (17 August 2018).

2. Fundamentals of 5G Mobile Networks, Jonathan Rodriguez Wiley, 1 edition (27 April 2015).

Reference textbooks

1. Signal Processing for 5G: Algorithms and Implementations, Fa-Long Luo and Charlie Jianzhong Zhang, Wiley-Blackwell, 1 edition (14 October 2016)

2. A Comprehensive Survey of RAN Architectures Toward 5G Mobile Communication System, Mohammad Asif Habibi, Meysam Nasimi, Bin Han, May 28, 2019, date of current version June 11, 2019.

3. Emerging wireless lans, wireless pans, and wireless mans, yang xiao yi pan, John Wiley & sons, inc., publication, 2009.

4. Wireless communication standards, Todor cooklev, IEEE press,2004

Paper 3

Course Name: Bio Medical signal Processing **Course Code: 25 EC301**

Syllabus

Introduction To Biomedical Signals - Examples of Biomedical signals - ECG, EEG, EMG etc., Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of bio potentials - Review of linear systems - Fourier Transform and Time Frequency Analysis (Wavelet) of biomedical signals- Processing of Random & Stochastic signals – spectral estimation – Properties and effects of noise in biomedical instruments - Filtering in biomedical instruments.

Concurrent, Coupled and Correlated Processes - Illustration with case studies – Adaptive and optimal filtering - Modeling of Biomedical signals - Detection of biomedical signals in noise -removal of artifacts of one signal embedded in another -Maternal-Fetal ECG - Muscle-contraction interference. Event detection - case studies with ECG & EEG - Independent component Analysis - Cocktail party problem applied to EEG signals - Classification of biomedical signals.

Cardio Vascular Applications: Basic ECG - Electrical Activity of the heart- ECG data acquisition – ECG parameters & their estimation - Use of multi-scale analysis for ECG parameters estimation - Noise & Artifacts- ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection - Arrhythmia analysis

Data Compression: Lossless & Lossy- Heart Rate Variability – Time Domain measures - Heart Rhythm representation - Spectral analysis of heart rate variability - interaction with other physiological signals.

Neurological Applications: The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models – Non-linear modeling of EEG - artifacts in EEG & their characteristics and processing – Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis – correlation analysis of EEG channels - coherence analysis of EEG channels.

TEXT BOOKS

1. D.C.Reddy ,“Biomedical Signal Processing: Principles and techniques” ,Tata McGraw Hill, New Delhi, 2005.
2. Willis J Tompkins , Biomedical Signal Processing -, ED, Prentice – Hall,1993

REFERENCES BOOKS

1. R. Rangayan, “Biomedical Signal Analysis”, Wiley2002.
2. Bruce, “Biomedical Signal Processing & Signal Modeling,” Wiley,2001.
3. Sörnmo, “Bioelectrical Signal Processing in Cardiac & Neurological Applications”, Elsevier.
4. Semmlow, “Bio-signal and Biomedical Image Processing”, MarcelDekker
5. Enderle, “Introduction to Biomedical Engineering,” 2/e, Elsevier,2005

Paper 3

Course Name: Advanced Embedded Processor Architecture **Course Code: 25 EC302**

Syllabus

ARM Processor as System-on-Chip: Acorn RISC Machine – Architecture inheritance – ARM programming model. 3 and 5 stage pipeline ARM organization – ARM instruction execution and implementation – ARM Co-processor interface.

ARM Assembly Language Programming: ARM instruction types – data transfer, data processing and control flow instructions – ARM instruction set – Co-processor instructions, Thumb Instruction Set.

Architectural Support for System Development: Advanced Microcontroller bus architecture – ARM memory interface – ARM reference peripheral specification – Hardware system prototyping tools – ARMulator – Debug architecture.

ARM Processor Cores: ARM7TDMI, ARM8, ARM9TDMI, ARM10TDMI, the AMULET Asynchronous ARM Processors- AMULET1

Embedded ARM Applications: The VLSI Ruby II Advanced Communication Processor,

The VLSI ISDN Subscriber Processor, The OneC™ VWS22100 GSM chip, The Ericsson-VLSI, Bluetooth Baseband Controller, The ARM7500 and ARM7500FE.

Text Books:

1. ARM System on Chip Architecture – Steve Furber – 2nd ed., 2000, Addison Wesley Professional.
2. Design of System on a Chip: Devices and Components – Ricardo Reis, 1st ed., 2004, Springer

References:

1. Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology) – Jason Andrews – Newnes, BK and CDROM
2. System on Chip Verification – Methodologies and Techniques – Prakash Rashinkar, Peter Paterson and Leena Singh L, 2001, Kluwer AcademicPublishers

Paper 3

Course Name: Wireless Cellular Communications **Course Code: 25 EC303**

Syllabus

Introduction to Cellular Mobile Systems: Cellular Mobile Telephone Systems, A Basic Cellular System, Operation of Cellular Systems.

Elements of Cellular Mobile Radio System Design: General Description of the problem, Concept of Frequency reuse channels, Co-Channel Interference Reduction Factor, Handoff Mechanism, Cell Splitting.

Speech Coding for Wireless Systems Applications: Introduction to Digital Signal Processing (DSP) Techniques in Wireless Telephone and Broadcast Systems, Speech Coding Techniques for Audio and Voice – Pulse Code Modulation, DPCM, Delta Modulation, Vocoder and Linear Predictive Coding, Performance Comparison of Speech Processing Techniques.

Radio Propagation and Cellular Engineering Concepts: Fundamental Radio Propagation and System Concepts, Propagation Characteristics, Models of Multipath-faded radio signals – Un modulated Carrier, Envelope and Phase faded, Level Crossing rate and fade Duration, Delay Spread Measurements.

Digital Modulation-Demodulation (Modem) Principles and Architectures: Coherent Modem – Baseband Modem Equivalence, Coherent and Differentially Coherent Binary Phase Shift Keying Systems, Synchronization – Carrier Recovery and Symbol Timing Recovery, Differential Encoding and Decoding Requirement, Quadrature Phase shift Keying – Coincident and offset Types, Pi/4 DQPSK Modems – Architecture.

Interference In Wireless Digital Communication: Carrier-to-Interference and Carrier-to- Noise Limited Systems, Co-channel Interference, Adjacent Channel Interference. Externally caused Co-channel Interference, Definitions and performance of Spectral and Power Efficiency, Relationship of the Bit-Energy to Noise-Density Ratio and the Carrier-to-Noise Ratio, Power Efficiency and Bit-Error-Rate performance in an Additive White Gaussian Noise Environment, Concepts of Diversity Branch and Signal paths; Combining and Switching Methods.

TEXT BOOKS

1. DR Kamilo Feher Wireless Digital Communications, Prentice Hall of India, New Delhi –1999
2. William Cy Lee, Mobile Cellular Telecommunications, 2nd Edition, MC GrawHill.

Paper 3

Course Name: Natural Language Processing **Course Code: 25 EC304**

Syllabus

Introduction to NLP. Language Structure and Analyzer - Overview of language, requirement of computational grammar. Words and their Analysis. Tokenization. Stemming. Morphological Analysis. POS tagging.

Local word grouping. Paninian Grammar - The semantic model, Free word order and vibhakti, Paninian theory, Active, Passive, Central. Paninian Parser - Core parser, constraint parser, preference over parses, lakshan charts, sense disambiguation. Machine Translation.

Lexical functional grammar, LFG and Indian languages, Tree Adjoining Grammar, Comparing TAG and PG. Automatic parsing: rules based and statistical. Introduction to some other NLP applications, depending on availability of time.

Some applications of machine learning in NLP such as Shallow Discourse Parsing. Statistical machine translation.

TEXTBOOK:

1. Speech and Language Processing by Jurafsky and Martin
2. Natural Language Processing: A Paninian Perspective by Akshar Bharati, Vineet Chaitanya and Rajeev Sangal

Paper 3

Course Name: Advanced Computational Mathematics **Course Code: 25 EC305**

Syllabus

Introductory Topics ALGEBRA, VECTORS AND GEOMETRY: *Solution of equations *Linear algebra : Determinants, matrices * Vector algebra & solid geometry CALCULUS: *Differential calculus and its applications *Partial calculus and its applications *Integral calculus and its applications

*Multiple integrals and beta, gamma functions *Vector calculus and its applications SERIES: *Infinite series *Fourier series

DIFFERENTIAL EQUATIONS: *Differential equations of first order *Applications of differential equations of first order *Linear differential equations *Applications of linear differential equations

*Differential equations of other types *Series solution of differential equations and special functions

*Partial differential equations *Applications of partial differential equations

Probability, random variables and stochastic processes: Fundamentals of probability and statistics: The Concept of a Random Variable, functions of one and two random variables, probability distribution functions, statistics. Stochastic Processes: General concepts, Random Walks and Other Applications, Spectral Representation, Spectrum Estimation, Mean square estimation, Entropy. Markov Chains, Markov Processes and Queueing Theory.

NUMERICAL TECHNIQUES: (Selected topics) *Empirical laws and curve-fitting *Statistical methods

*Probability and distributions *Sampling and interface *Finite differences and interpolation *Numerical differentiation and integration *Difference equations *Numerical solution of ordinary differential equations *Numerical solution of partial differential equations *Linear programming

TEXTBOOK:

1. Higher Engineering Mathematics: BS Grewal
2. Probability, random variables, and stochastic processes: A. Papoulis, S. Unnikrishna Pillai, MacGraw Hill

Paper 3

Course Name: EMI/EMC **Course Code: 25 EC306**

Syllabus

EMI Environment: Sources of EMI, Conducted and Radiated EMI, Transient EMI, EMI – EMC Definitions and Units of Parameters.

EMI Specifications/Standards/Limits: Units of specifications, Civilian Standards and Military Standards

EMI Control Techniques: Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient
Suppressors, Cable Routing, Signal control, Component Selection and mounting.

EMC Design Guidelines: Typical Sub systems in Electronic Equipment, Transmitters, Receivers, Antenna
Systems, Power Supplies, Motors, Control Devices, Digital Circuits, Digital Computers.

Choice of Passive Components for EMC: Capacitors, Inductors, Transformers, Resistors, Conductors,
Ferrite Beads, Coaxial Connectors, Conductive Gaskets.

EMI Measurements: EMI Test Instrument / Systems, EMI Test, EMI Shielded Chamber, Open Area Test
Site, TEM cell Antennas

TEXT BOOKS:

1. V P Kodali, Engineering EMC Principles, Measurements and Technologies, IEEE press,1996.
2. Bernard Kieser, Principles of Electromagnetic Compatibility, Artech House 3rd Edition, 1986

Paper 3

Course Name: MEMS Measurement Techniques **Course Code: 25 EC307**

Syllabus

Introduction: Macro-Meso, Micro and Nanostructure of Materials, Fundamentals of crystallography and Crystal structures Optical Microscopy: Geometry of Optics, Resolution, and Construction of a Microscope, Image Contrast, and Phase Contrast. Electron Microscopy: SEM: Electron Optics - Interaction of Electrons and Matter - Elastic and Inelastic Scattering, Backscattered Electrons, Secondary Electrons,
Materials For MEMS - Substrate and wafer, silicon as a substrate material, silicon compound, silicon Piezo-resistors, Gallium Arsenide, quartz, Piezoelectric crystals, polymers:Polymide,SU-8,Liquid Crystal Polymers, PDMS, PMMA, mechanical properties of polymers and packaging Materials Microscopy – Image Formation, magnification, and depth of field, distortion, detectors, Contrast, and Resolution. TEM: Electron diffraction, different electron Diffraction techniques, Atomic Force Microscopy(AFM): Construction and principle, Surface & optical profilometry, Semiconductor Material Impurity Characterization: Spectroscopic Ellipsometry (SE), X-ray Reflectivity (XRR), X-ray Fluorescence (XRF), X-ray Diffraction (XRD), Secondary Ion Mass Spectrometry (SIMS), Auger Electron Spectrometry(AES), Rutherford Backscattering Spectrometry, FTIR.

Electrical Characterization- Four-probe technique, Hall Effect, sheet resistance C-V measurements, Carrier lifetime, impurity profiling, I-V measurements

Case Study- Optical characterization of MEMS cantilever, piezoelectric, capacitive, Magneto-motive, piezo-resistive, dielectric gradient, Electro thermal actuation schemes for cantilever sensors.

ReferenceBooks:

1. Fundamentals of Micro Fabrication by *MarcMadou*
2. Microsystem Design by *Stephen D.Senturia*, Springer InternationalEdition,2010
3. RF MEMS Theory, Design and Technology by *Gabriel M.Rebeiz*, Wiley India Pvt Ltd.
4. MEMS and Microsystems: Design and Manufacture by *Tai-Ran Hsu,* Tata McGraw Hill,2002
5. The MEMS Handbook, *Mohamed Gad-el-Hak*, CRC Press, 2002.
6. Foundations of MEMS by *Chang Liu*, PearsonPublications

Paper 3

Course Name: Antenna Measurements **Course Code: 25 EC308**

Syllabus

Antenna Pattern Measurements: Basic Considerations, Pattern Formats, Fresnel Region Measurements, Modeling Techniques.

Antenna Range Design and Evaluation: Introduction, Electromagnetic Design Consideration, Antenna Range Evaluation.

Antenna Testing: Introduction, Types of Ranges: Elevated Ranges, Ground Ranges, Near Field Ranges, Radar Cross Section Ranges.

Far Field Range Design: Introduction, Designing the Range, Source Design, Receiving Site Design, Ground Ranges.

Far Field Antenna Tests: Introduction, Pattern Testing, Gain and Directivity, Polarization. Far

Field Pattern Errors: Introduction, Error Estimates, Error Correction, Antenna Errors. Compact

Ranges: Introduction, Room Design, Feed Design, Reflector Design.

Near Filed Testing: Introduction, Planar Near Field Ranges, Errors, Cylindrical and Spherical Scanning.

TEXT BOOKS

1. Evans, Gray E," Antenna measurements techniques", Artech House,Inc
2. J S Hollis, T J Lyon, L Clayton," Microwave Antenna Measurements”
, Scientific Atlants,Inc

Paper 3

Course Name: VLSI SYSTEM DESIGN AND VERIFICATION **Course Code: 25 EC309**

Syllabus

Design Methodology: Introduction to Digital VLSI Design Flow, High Level Design Representation, Transformations for High Level Synthesis.

Scheduling and Allocation: Scheduling, Allocation and Binding Problem, Scheduling Algorithms, Binding and Allocation Algorithms, Allocation Techniques: Clique Partitioning, Left- Edge Algorithm, Iterative, Refinement.

Logic Optimization and Synthesis: Two level Boolean Logic Synthesis, Heuristic Minimization of Two Level, Finite State Machine Synthesis, Multilevel Implementation. Binary Decision Diagram: Introduction and construction, Ordered Binary Decision Diagram, Operations on Ordered Binary Decision Diagram, Ordered Binary Decision Diagram for Sequential Circuits.

Temporal Logic: Introduction and Basic Operations on Temporal Logic, Syntax and Semantics of CLT, Equivalence between CTL Formulas. Model Checking: Verification Techniques, Model Checking Algorithm, Symbolic Model Checking.

Text Books:

1. G. De Micheli. Synthesis and optimization of digital circuits, 1994, 1st Edition

2. Douglas L Perry Harry D Foster, Applied Formal Verification, McGraw Hill, 2005, 1st Edtion

3. William K Lam, Hardware Design Verification: Simulation and Formal Method-based Approaches, Prentice Hall, 2008.

Reference Books:

1. M. Huth and M. Ryan, Logic in Computer Science modeling and reasoning about systems, Cambridge University Press, 2004, 2nd Edition,

2. D. D. Gajski, N. D. Dutt, A.C.-H. Wu and S.Y.-L. Lin, High-Level Synthesis: Introduction to Chip and System Design, Springer, 1992, 1st Edition

3. M. L. Bushnell and V. D. Agrawal, “Essentials of Electronic Testing” ,3rd Kluwer Academic Publishers 2002

Paper 3

Course Name: CMOS ANALOG IC DESIGN **Course Code: 25 EC310**

Syllabus

MOS device models and short channel effects: MOSFET level 1 and level 2 models, threshold voltage model, capacitance model, mobility model, MOSFET basics, small-signal model derivation for a single transistor amplifier Process, voltage, temperature (PVT) dependency.

Single Stage Amplifier: Basic concept, Common source stage: with resistive load, with diode connected load, with current source load, with triode load, with source degeneration. Source follower (common-drain) and common gate with various loads.

CMOS Differential amplifiers: Single ended differential operation, basic differential pair (qualitative and quantitative analysis), common mode response, differential pair with MOS loads and Gilbert cell multiplier, Concept of matching transistors for analog layout, analog layout techniques for differential amplifier.

Current mirrors and Amplifiers: Scheme and implementation: basic current mirrors, cascode current mirrors and active current mirrors with large and small signal analysis, CMOS amplifier Frequency response, Noise analysis of the CMOS amplifier circuits, Feedback topologies (voltage-voltage, current-voltage, voltage-current, current-voltage) and the noise and the loading effect analysis, Design of the CMOS operational amplifiers, Stability and frequency compensation

Text book:

1. "Design of Analog CMOS Integrated Circuits" by Behzad Razavi, McGraw Hill Education (1 September 2000)

Reference books:

1. "CMOS Analog Circuit Design" by Phillip Allen and Douglas R. Holberg, OUP USA; Third Edition edition (1 September 2011).

2. "Operation and Modeling of the MOS Transistor" by Yannis Tsividis, Oxford University Press; 2 edition, June 26, 2003

3. "Microelectronic Circuits-Theory & Applications" by A.S. Sedra and K.C. Smith, Adapted by A.N. Chandorkar, 6th Edition, Oxford, 2013.

Paper 3

Course Name: TESTING OF VLSI CIRCUITS **Course Code: 25 EC311**

Syllabus

Testing and Test Approaches: Introduction, Test challenges, Fault models - Defects, errors, and faults, Functional Vs structural testing, Stages of fault models, Stuck-at faults, Logic, and fault Simulation: design verification and test evaluation, Modeling circuits for evaluation, Algorithms for fault simulation, Statistical approach for fault simulation

Test generations and Algorithms: Test generation for combinational circuits – Algorithms and illustrations, Redundancy identification, Combinational ATPG algorithms, Test generation systems. Test generation algorithms for sequential circuits, and BIST

Design for Testability: Design for Testability -Ad-hoc design - Generic scan-based design - Classical scan-based design- System level DFT approaches. Self-Test and Test Algorithms- Test generation for Embedded RAMs.

Verification with System Verilog: The concept of Device under test (DUT), Complexity of verification, SV verification environment - Basics of SV testbench, concurrency in SV, encapsulation, and randomization. Inter-thread communications, mailbox, code coverage, functional coverage, and building efficient SV test benches. System Verilog UVM.

Text Books:

1. Michael L. Bushnell &Vishwani D. Agrawal,” Essentials of Electronic Testing for Digital,

memory & Mixed signal VLSI Circuits”

2. Chris Spears, System Verilog for Verification, 2nd Edition, Springer, 2008

3. Miron Abramovici, Melvin A. Breuer, Arthur D. Friedman, “Digital Systems Testing and

Testable Design”

Reference Books:

1. Jan M. Rabaey, AnanthaChandrakasan, Borivoje Nikolic, “Digital Integrated Circuits”

2. Neil H. E. Weste, David. Harris and Ayan Banerjee, “CMOS VLSI Design”

2. P. K. Lala, “Fault Tolerant and Fault testable hardware design”

4. N.N.Biswas “Logic Design Theory”

Paper 3

Course Name: ADVANCED MIXED SIGNAL IC DESIGN **Course Code: 25 EC312**

Syllabus

Submicron CMOS: Overview and Models, CMOS process flow, Capacitors, and Resistors. Digital circuit design: The MOSFET Switch, Delay Elements, and An Adder. Analog Circuit Design: Biasing, Op-Amp Design, Circuit Noise.

Integrator Building Blocks- low pass filter, Active RC integrators, MOSFET-C Integrators, gm- C integrators, Discrete-time integrators. Filtering Topologies: The Bilinear transfer function, The Biquadratic transfer function, Filter using Noise shaping.

DAC Architectures- Resistor string, R-2R ladder Networks, Current Steering, Charge Scaling DACs, Cyclic DAC, and Pipeline DAC. ADC Architectures- Flash, Two-step Flash ADC, Pipeline ADC, Integrating ADCs, Successive Approximation ADC.

Sampling and Aliasing: A modeling approach, Impulse sampling, The sample and Hold, Quantization noise. Data converter SNR: An overview, Clock Jitter, Improving SNR using Averaging, Decimating filter for ADCs, Interpolating filter for DACs, Band pass and High pass filters - Using feedback to improve SNR. OSCILLATORS AND PLL: LC oscillators, Voltage Controlled Oscillators. Simple PLL, Charge pumps PLLs, Non-ideal effects in PLLs, Delay Locked Loops.

Textbook:

1. CMOS Mixed Signal Circuit Design by R. Jacob Baker, Wiley India, IEEE Press, reprint 2008.

2. Design of Analog CMOS Integrated Circuits by Behzad Razavi, McGraw Hill, 33rd Re- print, 2016.

Paper 3

Course Name: Microwave and Millimeter wave Circuits **Course Code: 25 EC313**

Syllabus

Analysis of Microwave Circuits: Introduction, Microwave Components – E-plane Tee, H- plane Tee, Magic Tee, Directional Coupler, Isolator, Circulator & their Scattering.

Transformers & Resonators: Parameters, Impedance Transformers – Quarter wave Transformers, Microwave Resonators – Rectangular and Cylindrical Resonators.

Filters And Periodic Structures: Design of Narrow Band Low Pass, Band Pass and High Pass Filters, Maximally flat and Chebyshev Designs, Introduction to Periodic Structures, Floquet's Theorem, Circuit Theory Analysis of Infinite and Terminated Structures.

Obstacles In Wave Guides: Introduction, Posts in Waveguides, Diaphragms in Waveguides, Waveguide Junctions, Waveguide Feeds, Excitation of Apertures.

Millimeter Wave Circuits: Wave Propagation in micro-strip lines, Discontinues in Micro-strips, Parallel Coupled lines, Power Dividers and Directional Couplers, Microwave and Millimeter Wave Integrated Circuits

TEXT BOOKS

1. Roger F. Harrington, "Time-Harmonic Electromagnetic Fields", Mc graw-hill
2. Robert E Collin, "Foundation For Microwave Engineering", McGraw-Hill.

REFERENCE BOOKS

1. Analysis Methods for RF, Microwave, and Millimeter-Wave Planar Transmission Line Structures by Cam Nguyun.

Paper 3

Course Name: Pattern Recognition **Course Code: 25 EC314**

Syllabus

Pattern & Pattern classes, Pattern recognition Design Cycle, Feature Extraction: Feature processing & normalization, Learning (Supervised, Unsupervised, Reinforced). Preliminary concepts and pre- processing phases, coding, normalization, filtering, linear prediction, Feature extraction and representation thresholding, contours, regions, textures, template matching, Hidden Markov Models, Taxonomy of pattern classifiers Performance measurement metrics: Confusion matrix, Accuracy, Precision, Recall, ROC curve, Area Under Curve (AUC), Confidence intervals. Data partitioning (K- fold cross validation, Leave one out , Leave m-out)

Data structure for pattern recognition, statistical pattern recognition, clustering Technique and application. Study of pattern classifiers: Supervised and unsupervised.

Pattern Classifiers: Statistical: Bayesian theorem, Bayesian classifier: Minimum distance, Maximum likelihood), Naïve Bayes, Linear Discriminant Analysis, k- nearest neighbour (KNN), Artificial Neural Network etc. and Case studies.

Clustering techniques and algorithms Deep learning Selected topics from research

papers TEXTBOOK:

1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001.
2. K. Fukunaga, Statistical pattern Recognition; Academic Press, 2000.
3. Devi V.S.; Murty, M.N., Pattern Recognition: An Introduction, Universities Press, Hyderabad, 2011

Paper 3

Course Name: RF BASED CMOS IC DESIGN **Course Code: 25 EC315**

Syllabus

Introduction to RF and Wireless Technology: Complexity, design, and applications. Choice of Technology. Basic concepts in RF Design: Nonlinearly and Time Variance, intersymbol Interference, random processes, and Noise. Definitions of sensitivity and dynamic range, conversion Gains, and Distortion. Analog and Digital Modulation for RF circuits: Comparison of various techniques for power efficiency. Coherent and Non-coherent defection.

Mobile RF Communication systems and basics of Multiple Access techniques. Receiver and Transmitter Architectures and Testing heterodyne, Homodyne, Image-reject, Direct-IF, and sub-sampled receivers. Direct Conversion and two steps transmitters.

BJT and MOSFET behavior at RF frequencies Modeling of the transistors and SPICE models. Noise performance and limitation of devices. Integrated Parasitic elements at high frequencies and their monolithic implementation. Basic blocks in RF systems and their VLSI implementation: Low Noise Amplifiers design in various technologies, Design of Mixers at GHz frequency range.

Various Mixers, their working, and implementations, Oscillators: Basic topologies VCO and definition of phase noise. Noise-Power trade-off. Resonatorless VCO design. Quadrature and single-sideband generators, Radio Frequency Synthesizes PLLS, Various RF synthesizer architectures, and frequency dividers, Power Amplifiers design. Linearization techniques, Design issues in integrated RF filters.

Text Books:

1) RF Microelectronics, Behzad Razavi, 2nd Edition, 2012 onwards, Pearson Education, Inc.

2) The Design of CMOS Radio-Frequency Integrated Circuits, Thomas Lee, 2nd Edition, 2004 onwards, Cambridge University Press.

Reference Books:

1) Design of Analog CMOS Integrated Circuits, Behzad Razavi, McGraw Hill Education, Second edition, 2017 onwards, McGraw Hill Education (India) Private Limited.

2) Relevant IEEE papers referenced in the class will be provided by the instructor.

Paper 3

Course Name: Image And Video Processing **Course Code: 25 EC316**

Syllabus

Fundamentals of Image processing and Image Transforms: Basic steps of Image processing system sampling and quantization of an Image – Basic relationship between pixels Image Transforms: 2 – D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms.

Image Processing Techniques: Image Enhancement: Spatial Domain methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial filters, Sharpening Spatial filters Frequency Domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, selective filtering Image Segmentation: Segmentation concepts, point, line and Edge detection, Thresholding, region based segmentation.

Image Compression Image compression fundamentals – coding Redundancy, spatial and temporal redundancy. Compression models : Lossy and Lossless, Huffmann coding, Arithmetic coding, LZW coding, run length coding, Bit Plane coding, transform coding, predictive coding , wavelet coding, JPEG standards.

Basic Steps of Video Processing: Analog video, Digital Video, Time varying Image Formation models : 3D motion models, Geometric Image formation , Photometric Image formation, sampling of video signals, filtering operations.

2-D Motion Estimation: Optical flow, general methodologies, pixel based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Waveform based coding, Block based transform coding, predictive coding, Application of motion estimation in videocoding.

TEXT BOOKS

1. Gonzalez and Woods , "Digital Image Processing", 3rd edition ,Pearson

2. Yao wang, JoemOstarmann and Ya – quin Zhang, "Video processing and communication", 1st edition,PHI.

REFERENCE TEXT BOOK

1. M. Tekalp, "Digital video Processing", Prentice HallInternational

SIMULATION TEXT BOOKS

1. Relf, Christopher G.,"Image acquisition and processing with LabVIEW", CRCpress

2. Aner ozdemi R, "Inverse Synthetic Aperture Radar Imaging with MATLAB Algorithms", John Wiley &Sons.

3. Chris Solomon, Toby Breckon ,"Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab", John Wiley &Sons.

<u>**Paper 3**</u>

Course Name: Nanoscale Engineering for Clean Energy **Course Code: 25 EC317**

<u>**Syllabus**</u>

Fundamental Concepts in Energy Systems: Electrochemical cell concepts, Nernst equation, Faraday's laws, Electrode Potentials, Thermodynamics of electrochemical cells, Polarization losses in electrochemical cells, Electrode process and kinetics, Electrical double layer, Photoelectrochemical cell.

Nanomaterials for Photovoltaic Solar Energy Conversion Systems: Principles of photovoltaic energy conversion (PV), Types of photovoltaics Cells, Organic photovoltaic cells, thin film Dye Sensitized Solar Cells, Quantum dot (QD) Sensitized Solar Cells (QD-SSC), Perovskite solar cells, Organic-Inorganic Hybrid Bulk Hetero Junction (BHJ-SC) Solar cells, Solar-water splitting, Current status and future trends.

Nanomaterials for Energy Storage (Batteries) Systems: Nanostructured Materials for electrochemical Energy Storage Systems, Primary and Secondary Batteries (Lithium-ion Batteries), Cathode and anode materials, redox-flow batteries for HEV/EV transportation and stationary applications, Nanostructured Carbon-based materials, Nano-Oxides, Novel hybrid electrode materials, Current status and future trends.

Renewable Energy: Nanogenerators and Hydrogen Energy Systems: Types of Nanogenerators: Piezoelectric, Thermoelectric, Pyro-electric, Electromagnetic, and Triboelectric, Key challenges for choosing nanomaterials for nanogenerators. Hydrogen energy generation, nanomaterials used for hydrogen energy generation & storage, methods to produce hydrogen energy and its key challenges, Current status and future trends.

Modelling & Simulation in Energy Systems: Problem formulation, constrained optimization and unconstrained problems, Necessary and sufficiency conditions, Design, develop and simulate various energy system (LAB) Design and simulation of energy storage and harvesting systems including batteries, supercapacitors, and energy harvesters (piezoelectric, triboelectric, thermoelectric). Evaluation of system performance using MATLAB. (SKILL)

Text Books:

1. Electrochemical methods: Fundamentals and Applications, Allen J. Bard and Larry R.
1. Faulkner, 2nd Edition, 2004, John Wiley & Sons. Inc.
2. Handbook of Batteries, D. Linden Ed., 1995, 2nd edition, McGraw-Hill, New York.
3. Lithium Batteries: Science and Technology, G.A. Nazri and G. Pistoia, 2004, Kulwer Acdemic Publishers, Dordrecht, Netherlands.
4. Fuel Cell System Explained, J. Larmine and A. Dicks, 2000, John Wiley, New York.
5. Nanogenerators: Basic Concepts, Design Strategies, and Applications, Inamuddin, M. I. Ahamed, R. Boddula and T. Altalhi, 2022, CRC Press, 1st Edition.

Reference Books:

1. Photoelectrochemical hydrogen generation, theory, materials advances, and challenges, Pooja Devi, 2022, Springer Publications, ISBN: 978-981-16-7285-9.

Science and Technology of Lithium Batteries-Materials Aspects: An Overview, A. Manthiram, 2000, Kulwer Academic Publisher.