Savitribai Phule Pune University
(Formerly University of Pune)
Board of Studies, Department of Technology
Electronics & Electrical (EE) Technology
Curriculum Structure for M.Tech Program

Sr. No.	Subject Code	Subject Name	Credits	Teaching Scheme (Theory)	Teaching Scheme (Lab)
Semester (I)					
1	MTC1	Mathematics for Technology	3	√	
2	EEC2	Embedded Systems and RTOS	3	√	
3	EEC3	Advanced Digital Signal Processing	3	√	
4	EEE1	Elective-1	3	√	
5	EEE2	Elective-2	3	√	
6	EEL1	Lab Practice - 1	3		√
7	EES1	Seminar - 1	1		√
Semester (II)					
8	EEC4	Communication Networks	3	√	
9	EEC5	Analytical Instrumentation	3	√	
10	EEE3	Elective-3	3	√	
11	EEE4	Elective-4	3	√	
12	EEE5	Elective-5	3	√	
13	EEL2	Lab Practice - 2	3		√
14	EES2	Seminar - 2	1		√
Semester (III)					
15	EED1	Soft Skills / Research Methodology	3	√	
16	EED2	Elective 6 /DS(Directed Study)	3	√	
17	EEMP1	Interim Project	8		√
Semester (IV)					
18	EEMP2	Final Project (Dissertation Submission)	18		√
		TOTAL CREDITS	70		

AUDIT COURSES				
Sr. No.	**Subject Code**	**Subject Name**	**Credits**	**Semester**
1	CYSA	Cyber Security	2	I
2	HRE101	Human Rights & Duties	1	II
3	HRE102/HRE103	Human Rights & Vulnerable Groups/Law Policy , Society & Enforcement mechanism	1	III

Notes:

1) Electives can also be Open Electives in spirit of CBCS.

2) Maximum 25% Open Electives are allowed.

3) Candidates are expected to perform minimum three (3) assignments for every Lab Practice, and submit report as a bona fide document to supervisor/course instructor. The assignment may be in the form of modeling/ simulation/ programming/ experimental investigation/ fieldwork

4) The candidates are expected to select three electives from the list provided in Table(s) in this document

Savitribai Phule Pune University
Board of Studies
Electronics & Electrical (EE) Technology
Curriculum Structure for Integrated M.Tech-PhD Program

Sr. No.	Subject Code	Subject Name	Credits	Teaching Scheme (Theory)	Teaching Scheme (Lab)
Semester (I)					
1	MTC1	Mathematics for Technology	3	√	
2	EEC2	Embedded Systems and RTOS	3	√	
3	EEC3	Advanced Digital Signal Processing	3	√	
4	EEE1	Elective-1	3	√	
5	EEE2	Elective-2	3	√	
6	EEL1	Lab Practice - 1	3		√
7	EES1	Seminar - 1	1		√
Semester (II)					
8	EEC4	Communication Networks	3	√	
9	EEC5	Analytical Instrumentation	3	√	
10	EEE3	Elective-3	3	√	
11	EEE4	Elective-4	3	√	
12	EEE5	Elective-5	3	√	
13	EEL2	Lab Practice - 2	3		√
14	EES2	Seminar - 2	1		√
Semester (III)					
15	EED1	Soft Skills / Research Methodology	3	√	
16	EED2	Elective 6 /DS(Directed Study)	3	√	
17	EED3	Elective 7 /DS(Directed Study)	3	√	
17	EES3	Seminar - 3	1		√
Semester (IV)					
18	EEPR	Ph.D Pre-registration	--		√

Semester (V)					
19	EER1	Ph.D Pre-registration	--		√
Semester (VI)					
20	EER2	Ph.D Pre-registration	--		√
Semester (VII)					
21	EER3	Ph.D Pre-registration	--		√
Semester (VIII)					
22	EER4	Ph.D Pre-registration	--		√
Semester (IX)					
22	EER5	Ph.D Pre-registration	--		√
Semester (X)					
22	EER6	Ph.D Pre-registration	--		√
Semester (XI)					
22	EEFP	Ph.D viva-voce presentation	--		√

AUDIT COURSE				
Sr. No.	**Subject Code**	**Subject Name**	**Credits**	**Semester**
1	CYSA	Cyber Security	2	I
2	HRE101	Human Rights & Duties	1	II
3	HRE102/HRE103	Human Rights & Vulnerable Groups/ Human Rights & Duties in India: Law Policy , Society & Enforcement mechanism	1	III

Notes:

1) Electives can also be Open Electives in spirit of CBCS.
2) Maximum 25% Open Electives are allowed.
3) Candidates are expected to perform minimum three (3) assignments for every Lab Practice, and submit report as a bona fide document to supervisor/course instructor. The assignment may be in the form of modeling/ simulation/ programming/ experimental investigation/ fieldwork
4) The candidates are expected to select three electives from the list provided in Table(s) in this document.

LIST OF ELECTIVES FOR ELECTRONICS & ELECTRICAL BOARD

Sr. No	Subject Code	Subject Name
1	EEE1	Advanced Control Systems
2	EEE2	Digital Signal Processing Architectures
3	EEE3	Reconfigurable Computing
4	EEE4	Image Processing
5	EEE5	Instrumentation Communication Protocols
6	EEE6	CMOS IC Design
7	EEE7	Transducers and Designs
8	EEE8	Wave Theory and Microwave Circuits
9	EEE9	Multi-Resolution Analysis
10	EEE10	Audio and Video Coding Standards
11	EEE11	Optimal Control Systems
12	EEE12	High-power Electronic Devices
13	EEE13	Energy Auditing and Conservation
14	EEE14	Solar and Wind Energy
15	EEE15	Telecom Management
16	EEE16	Robotics
17	EEE17	Engineering Ethics
18	EEE18	Antenna and radiating System
19	EEE19	Machine Vision and Pattern Analysis
20	EEE20	System on Chip
21	EEE21	Applied Linear Algebra
22	EEE22	Energy Auditing and Conservation

23	EEE23	Advanced Digital Signal Processing II
24	EEE24	Biomedical Instrumentation and Bio Signal Processing
25	EEE25	Nano Technology
26	EEE26	Renewable Energy Sources and Opportunities
27	EEE27	Advanced Process Control
28	EEE28	Artificial Intelligence
29	EEE29	DSP on FPGA
30	EEE30	Machine Learning
31	EEE31	Cognitive Radio
32	EEE32	Power Electronics
33	EEE33	Advanced Computer Vision
34	EEE34	Advanced Embedded Systems
35	EEE35	PEM Fuel Cell Theory and Automotive Applications
36	EEE36	Solar Electrical Systems and Applications
37	EEE39	Smart Grid Technologies and Applications
38	EEE40	PEM Fuel Cell Theory and Automotive Applications
39	EEE41	Internet of Things
40	EEE42	Analysis of Integrated Electronics Applications
41	EEE43	Power system dynamics and stability
42	EEE44	Electrical power distribution system
43	EEE45	Power Quality And Grid Connected PV System
44	EEE46	Thin Film Technology
45	EEE47	Advanced Machine Learning
46	EEE48	Smart Grid Solar Photovoltaic

47	EEE49	Embedded System Design and Modelling
48	EEE50	Mechatronics and Transducers
49	EEE51	Modeling and Simulation
50	EEE52	Intellectual Property Rights
51	EEDS1	Analog & Digital CMOS VLSI Design
52	EEDS2	Discrete-time Signal Processing System
53	EEDS3	Adv. Lithography

MATHEMATICS FOR TECHNOLOGY (COMPUTATIONAL METHODS)

Unit 1: Numerical differentiation I:

Partial differential equation Laplace and Poisson's equation-solution, method of characteristics for solution of initial boundary value problems, relaxation method

Unit 2: Numerical differentiation II:

Finite Difference, Gaussian elimination and Gauss, Jordan methods, matrix inversion, Gauss Seidel method –Newton- Raphson method

Unit 3: Statistics and Probability:

Moments, Skewness and Kurtosis, Probability, conditional probability, various theoretical distributions like binomial, normal, log-normal, Poisson, gamma distribution, Pearson type I, II & II distribution test of significance, Gumbel distribution, testing of hypotheses – Large sample tests for mean and proportion, Chi-square test, errors, types of errors.

Unit 4: Regression and Correlation:

Regression and correlation – rank correlation – multiple and partial correlation – analysis of variance-one way and two way classifications – experimental design – Latin square design

Unit 5: Transforms:

Laplace Transformer: LT of standard function, inversions and their application in civil engg. Fourier Transformer: Fourier integral, Fourier transform and their application in civil engg.

Unit 6: Matrix method and Finite element:

Matrix method analysis (Stiffness) co ordinate calculation for different types of structure. Finite element method basics (1D and 2D) co ordinate calculations.

Reference Books

1. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).
2. Venkatraman, M.K., Numerical Methods in Science and Engineering, National Publisher Company.
3. Numerical Methods by Krishna Raju
4. Shanthakumar M.S., Numerical Methods & Analysis
5. Gupta, S.C. and Kapur, V.K., "Fundamentals of Mathematical Statistics ", Sultan Chand & Sons, New Delhi, 1999.

S.P.Pune University
Department of Technology
SYLLABUS FOR MTech- Integrated MTech-PhD (Electronics and Electrical Technology)

Embedded Systems and RTOS

Concepts & types of Memory, Cache Memory, mapping techniques, replacement policies. Full custom/VLSI, Logic Families, ASICs, PLDs, PALs, CPLDs, FPGA. Packaging, Circuit Boards, Interconnection and Signal Integrity. General Purpose Processor, System On chip, Embedded Computer Organization. ARM 7/ARM 9 architecture, ARM Microcontrollers and Processor Cores, Instructions and Data handling, interfacing with Memory, Interrupts, Timers, ARM Bus. I/O Devices, Controllers. Parallel, Multiplexed, Tristate, and Open-Drain Buses, Bus Protocols. Operating System Concepts, Processes, Deadlocks, Memory Management, Input/Output, Files, Security, Shell. Operating system structure, Layered Systems, Virtual Machines, Exo-kernels, Client-Server Model, Real Time Operating Systems (µC/OS):Real-Time Software Concepts, Kernel Structure, Task Management, Time Management, Inter task Communication & Synchronization, Memory Management, and Porting µCos-II. Linux/RT Linux: Features of Linux, Linux commands, File Manipulations, advances like GLS, GPSS, GMS. Multiprocessor communication. Case study- cruise control of car. Artificial Intelligence and engine management.

Reference books

1. Embedded Real Time Systems: Concepts, Design & Programming, Dr. K.V.K.K. Prasad, Dreamtech Publication.

2. µCOS-II, The real time Kernel, Jean J. Labrossy, Lawrence: R & D Publications.

Advanced Digital Signal Processing

Overview of DSP,FIR filters, IIR filters, design techniques of linear phase FIR filters, IIR filters by impulse invariance, bilinear transformation, Linear prediction & optimum linear filters stationary random process, forward- backward filters linear prediction, solution of normal equation, Multirate DSP, Sampling rate conversion, polyphase filters, multistage decimator & interpolator, QMF, digital filter banks, Adaptive filters & spectral estimation, Minimum mean square criterion, LMS algorithm, Recursive least square algorithm, DFT in spectral estimation, Applications of DSP & Multirate DSP, Application to Radar, introduction to wavelets, application to image processing, design of phase shifters & other applications

Reference books :

1. *J.G.Proakis and D.G.Manolakis Digital signal processing: Principles, algorithm and applications, Macmillan publishing*
2. *Salivahanan, Vallavaraj & Gnanpriya Digital signal processing:: Tata Mcgraw Hill*
3. *S.W.Smith Digital signal processing: A practical guide for engineers and scientists, Elsevier*
4. *S.K.Mitra , Digital signal processing:: Tata Mcgraw Hill*

Communication Networks

Network and Transport Layers, Mobile IP, TCP, Traditional, Indirect, Snooping, Mobile,TCP/IP protocol stack over IEEE 802.11b, wireless adaptation layer (WAL), ATM, Frame Relay, IEEE 802.11 WLANs analysis, deployment of 802.11 infrastructure, Bluetooth, core protocols, MANETs and WSNs. Mobile Ad Hoc networks, MAC Protocols - classification, comparative analysis, reactive and proactive routing, power-aware routing, performance comparison, Quality of Service. Wireless Sensor Networks, Data Dissemination, Data Gathering, MAC Protocols, Sensor Management, Localization. Conventional encryption, cipher-block, location of encryption devices, key distribution. Public key cryptography, RSA algorithm, diffie-hellman algorithms, message authentication, secure hash functions, HMAC, digital signatures, key management. Secrete Key Cryptography, DES, IDEA, AES. Network Security applications, Authentication applications email Security, PGP, SMIME IP Security, authentication on header, encapsulating security payload, combining security associations, key management. Web Security Requirements, SSL and TSL, SET.

Reference books

1. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall.

2. Jochen Schiller, "Mobile Communications", Addison Wesley.

Power system modelling and dynamics

Modeling of Power System Components: The need for modeling of power system, different areas of power system analysis. Simplified models of non-electrical components like boiler, steam & hydro-turbine & governor system. Transformer modeling such as auto-transformer, tap-changing & phase-shifting transformer. Analysis of synchronous machine modeling: Synchronous machine connected to an infinite bus, its simulation for steady-state condition Excitation system modeling : Simplified view of excitation control. Excitation configuration, primitive systems, Definitions of voltage response ratio & exciter voltage ratings. Excitation control systems using dc generator exciter, alternator-rectifier, alternator-SCR, voltage regulators such as electro-mechanical and solid state. Transmission line, SVC and load modeling. Review of Classical Methods : System model, states of operation and system security, steady state stability, transient stability, simple representation of excitation control. Dynamics of Synchronous Generator Connected to Infinite Bus: System model, simplified synchronous machine model, calculation of Initial conditions, system simulation, improved model of synchronous machine, inclusion of SVC model. Multi-machine System : Simplified model, Improved model of the system for linear load, Inclusion of dynamics of load and SVC, introduction to analysis of large power system. Islanding : Necessity for islanding, methods, use, advantages and disadvantages, implication on power system dynamic performance.

Reference books

1. K.R.Padiyar, "Power Systems Dynamics", B.S. Publications.

2. Kundur, "Power System Dynamics Control", IEEE Press.

Analytical Instrumentation

Introduction to chemical analysis, Classical and Instrumental methods, Classification of Instrumental techniques, important considerations in evaluating an instrumental method. Absorption methods: Spectrometric UV, VIS, Laws of photometry, IR spectrometry, correlation of IR spectra with molecular structure. Atomic absorption spectrometry, Emission methods. Flame, AC/DC arc, spark, plasma excitation sources. Spectrofluroscence and phosphorescence spectrometer, Raman spectrometer. Mass spectrometer, Ionisation methods, mass analysers, mass detectors, FTMS. Chromatography, Gas chromatography, Liquid chromatography. X-ray and Nuclear methods, x-ray absorption, fluorescence and diffractometric techniques, electron microscope and microprobe, ESCA and Auger techniques, nuclear radiation detectors. NMR spectroscopy, chemical shift, spin-spin coupling, types of NMR. Electroanalytical methods, potentiometry, voltammetry, coulometry techniques.

Reference books

1. Willard, Merritt, Dean and Settle, "Instrumental Methods of Analysis", CBS publishers.

2. Galen W. Ewing, "Instrumental Methods of Chemical Analysis", McGraw- Hill.

Biomedical Instrumentation and Bio Signal Processing

DSP and Analog Signal Processing, Discrete Time Signals and Systems: classification of signals-continuous and discrete time signals, periodic and a periodic signals, even and odd signals, energy and power signals, operations on sequences- shifting, folding, addition, multiplication, scaling, etc., classification of systems- linear vs. nonlinear ,time variant vs. time invariant, causal vs. noncausal , stable vs. unstable system, impulse response, convolution, sampling process, aliasing, antialiasing filter, reconstruction, correlation, autocorrelation. DFTs, Digital Filters, FIR Filters, removal of noise, motion artifacts from ECG, Bilinear transformation method, removal of high frequency noise and periodic events using different IIR filters. Integer filters. Adaptive cancellation, adaptive cancellation of maternal ECG from Fetal ECG of interest. Commercial DSP processors. Biotransducers: Srain Gauge, Blood pressure transducers, Thermo resistive transducers, infrared thermometry; Optical pyrometer, nasal air flow measurement. Biopotential Measurement: Origin of Biopotentials, Electrolyte interface, polarization, motion artifact. Electrodes for ECG, EMG, EEG. Biomedical Instrumentation: Cardiovascular System, Heart Structure, Cardiac Cycle, ECG Theory, Pulmonary function measurement; Spirometry, Doppler Blood Flow Meters, Cell counting, Electrical safety.

Reference books

1. Harry.N. Norton, "Biomedical Sensors - Fundamentals and applications", William Andrew Publications.

2. Willis J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall.

Nanotechnology

The fundamental science behind nanotechnology, bio systems, molecular recognition, quantum mechanics & quantum ideas, optics. Smart materials & Sensors, self healing structures, heterogeneous nano structures & composites, encapsulations, natural nanoscale sensors, electromagnetic sensors, biosensors, electronic noses. Nanostructures, Micro/Nano devices, Nanomaterials Synthesis and Applications. Molecule-Based Devices, Carbon Nanotubes, Nanowires, Micro/Nanofabrication, Stamping Techniques. Methods and Applications. Materials Aspects of Micro and Nano electromechanical Systems, MEMS/NEMS Devices and Applications. Nano devices. Scanning Probe Microscopy, Noncontact Atomic Force Microscopy and Its Related Topics. Low Temperature Scanning Probe Microscopy, Dynamic Force Microscopy. Nanolithography, Lithoraphy using photons, electron beams, soft lithography. Biomedical applications.

References books

1. Springer Handbook of Nanotechnology ISBN: 978-3-540-35172-6

2. Mark Rattner, Daniel Rattner, "Nanotechnology: A Gentle Introduction to the Next Big Idea," ISBN-10:0-13-101400-5.

Renewable Energy Sources and Opportunities

Classification of Energy Sources, Energy needs, consumption patterns, Worldwide Potentials of sources, Energy efficiency, security, environmental impacts, Kyoto Protocol, Clean Development Mechanism (CDM) and Prototype Carbon Funds (PCF), Factors affecting renewable energy sources, IRP. Solar Energy, Solar thermal Systems, collectors, efficiency, Photo voltaic (PV) technology, solar cells , cell technologies, characteristics of PV systems, equivalent circuit, Peak power operation, Standalone and grid interactive systems. Wind Energy, wind speed and power relation, wind distribution and speed predictions, Wind power systems, Turbines, Variable speed operation, maximum power operation, control systems, stand alone and grid connected operation. Biomass, energy contents, technological advancements, conversion, Gasifiers, Biomass fired boilers, Cofiring, harnessing issues. Hydro energy, small, mini and micro hydel plants scheme. Tidal and wave energy ,Geothermal and Ocean-thermal energy conversion

(OTEC) systems. Energy storage and hybrid system configurations, Battery, equivalent circuit, performance characteristics, battery design, charge regulators, management, Fly wheel energy relations, components, benefits over battery. Grid Integration, Stand alone, Hybrid systems, hybrid with diesel, with fuel cell, solar, wind, wind –hydro systems, mode controller, load sharing, system sizing, system economics. Effect on power quality.

Reference books

1. R. Ramesh, "Renewable energy technologies", Narosa Publication.

2. S. Rao, Parulkar , "Energy Technology".

Advanced Process Control

Review of Process Control basics, Control objective and benefits, Control system elements. Mathematical Modeling and dynamic performance analysis process for control, models from fundamental laws, empirical model identification, dynamic performance analysis of first order, second order, multi-capacity processes, Effect of Zeros and time delay. Multivariable Process control, Cascade control, Ratio control, feedback-feedforward control, override control, selective control, modeling of multivariable process, Design of Multivariable controllers. Model Based control: Feedback-feedforward, delay compensation, Internal Model controller (IMC). Model forms, DMC, SISO unconstrained DMC Problem, controller tuning, Statistical Process Control (SPC), Case study: Design of Fuzzy-Logic, Neural Network based controller.

Reference books

1. Thomas E. Marlin, "Process Control", McGraw-Hill.

2. Jose A. Romagnoli, Ahmet Palazoglu, "Introduction to process Control", CRC Taylor and Francis.

Artificial Intelligence

Introduction-Definition, What is A.I.? Foundation of A.I., History , intelligent Agents, Agent Architecture, A.I. Application(E Commerce & Medicine), A.I. Representation, Properties of internal representation Futures of A.I. Production System. and issue in Design of search Programs, Logic Programming – Introduction logic, Logic Programming, Forward and Backward reasoning, Forward and backward chaining rules, Heuristic search techniques- Heuristic search, Hill Climbing, Best first search, mean and end analysis, Constraint Satisfaction, A* and AO* Algorithm, Game Playing- Minmax search procedure, Alpha beta cutoffs, waiting for quiescence, Secondary search, Knowledge Representation –Basic of Knowledge representation Paradigms, Prepositional Logic, Inference Rules in Prepositional Logic, Knowledge representation using Predicate logic: Predicate Calculus, Predicate and arguments, ISA hierarchy Frame Notation, Resolution, Natural Dedication, Knowledge representation using non monotonic logic: TMS(Truth Maintenance system), Statistical and probabilistic reasoning ,fuzzy logic, structure knowledge representation ,semantic net ,Frames, Script, Conceptual dependency, Learning – What is Learning? Types of Learning (Rote, Direct instruction Analogy, Induction, Deduction), Planning- Block world, Strips, Implementation using goal stack, Non Linear planning with goal stacks, Hierarchical planning, least commitment strategy.

References books:

1. *Eiaine Rich and Kerin Knight: Artificial Intelligence*
2. *Eugene, Charniak, Drew Mcdermott: Introduction to artificial intelligence.*
3. *Kishen Mehrotra , Sanjay Rawika , K Mohan : Artificial Neural Network.*
4. *Herbert A Simon,The Sciences of the Artificial, MITPRESS, 3rd Edition (2nd Printing), 1995.*
5. *Ivan Bratko: Prolog Programming For Artificial Intelligence, 2nd Edition Addison Wesley ,1990*
6. *Stuart Russell & peter Nerving: Artificial Intelligence : A Modern Approach, Prentice Hall ,2nd Edition*

Power System Planning

Load Forecasting, Factors affecting, Load Growth, Characteristics, Classification of Load, Load Forecasting Methods, Energy Forecasting, Peak Load Forecasting, Reactive Load Forecasting, Non-Weather sensitive load, weather sensitive load Forecasting. System Planning, Objectives & Factors affecting to System Planning , Short Term-Medium Term-Long Term Planning, Reactive Power Planning. Reliability, Failure, Evaluation Techniques, Stochastic Prediction. Generation Planning and Reliability, Factors affecting, Integrated Resource Planning, Generation System Model, Capacity Expansion, Scheduled Outage, Loss of Energy, Evaluation Methods. Transmission Planning and Reliability, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability. Distribution Planning and Reliability, Radial Networks, Network Reconfiguration, Evaluation Techniques, Interruption Indices, Effects of Lateral Distribution Protection, Effects of Disconnects, Effects of Protection Failure, Effects of Transferring Loads, Distribution Reliability, Indices. Parallel & Meshed Networks, Evaluation Techniques, Bus Bar Failure, Scheduled Maintenance, Temporary and Transient Failure.

Reference books

1. Roy Billinton & Ronald N. Allan, "Reliability Evaluation of Power System", Springer Publication.

2. R.L. Sullivan, "Power System Planning", Tata McGraw Hill.

Advanced Control Systems

Example of multivariable control systems, differential operator and transfer matrix, state-space models, system solution. Controllability, observability, state estimation pole allocation, stability and reproducibility, minimal realization of multivariable control systems. Decoupling and model matching control, extension of classical theory to multivariable control systems. Optimal Control System, Pontryagin's minimum principle, application to discrete and continuous systems. Hamilton - Jacoby equation. Relation between the minimum principle and dynamic programming. Linear regular problem. Quadratic performance criterion. Minimum time problems, Bang Bang Control, singular solutions.

Reference Books

1. C. T. Chen, "Linear System Theory and Design", Oxford.

2. N. K. Sinha, "Multivariable Control", Marcel Dekker Inc.

Digital Signal Processing Architectures

Digital Signal Processing Overview, Convolution, Correlation, Digital filters, DFT, STFT, DCT, wavelets and filter banks. FFT algorithms, Representations of the DSP algorithms, Block diagrams, Signal flow graph, Data-flow graph, Dependence graph, bounds, Pipelining and Parallel processing of FIR filters, Algorithm transformation, Retiming, Folding, Unfolding, Algorithmic strength reduction in Filters and Transforms, Fast FIR algorithms. Parallel processing for IIR filters, memory management, I/O management, On chip resources, programming considerations, Real time implementations, Applications of DSP systems: FIR filters, IIR filters, DTMF generation and detection, wavelet algorithms, Adaptive algorithms: system identification, modeling, noise cancellation, prediction. DSP processor architecture, Software developments, Selections of DSP processors, Implementation considerations, finite word length effects, real time implementation, Hardware interfacing. TMS 320C54XX, TMS 320C67XX, Blackfin processor: Architecture overview, memory management, I/O management, On chip resources, programming considerations, Real time implementations, Applications of DSP systems Design using fixed and floating point.

Reference books:

1. Sen M. Kuo and Woon-Seng Gan, " Digital Signal Procesors, architectures, implementations, and applications", Prentice-Hall, ISBN 0130352144.

2. K. K. Parhi, "VLSI Digital Signal Processing Systems- Design and Implementation", John Wiley & Sons, Inc.

Reconfigurable Computing

Computing requirements, Area, Technology scaling, Instructions, Custom Computing Machine, Overview, Comparison of Computing Machines. Interconnects, Requirements, Delays in VLSI Structures; Partitioning and Placement, Routing; Computing Elements, LUT's, LUT Mapping, ALU and CLB's, Retiming, Fine-grained & Coarse-grained structures; Comparison of different architectures viz. PDSPs, RALU, VLIW, Vector Processors, Memories, Arrays for fast computations, CPLDs, FPGAs, Multicontext, Partial Reconfigurable Devices; TSFPGA, DPGA, Mattrix; Best suitable approach for RD; Case study. Control Logic, Binding Time and Programming Styles, Overheads, Data Density, Data BW, Function density, Function diversity, Interconnect methods, Best suitable methods for RD; Contexts, Context switching; Area calculations for PE; Efficiency, ISP, Hot Reconfiguration; Case study. Architectures for existing multi FPGA systems, Compilation Techniques for mapping applications described in a HDL to reconfigurable hardware, Study of existing reconfigurable computing systems to identify existing system limitations and to highlight opportunities for research; Software challenges in System on chip; Testability challenges; Case studies. Modelling , Temporal portioning algorithms, Online temporal placement, Device space management, Direct communication, Third party communication, Bus based communication, Circuit switching, Network on chip, Dynamic network on chip, Partial reconfigurable design.

Reference books

1. Andre Dehon, "Reconfigurable Architectures for General Purpose Computing".

2. IEEE Journal papers on Reconfigurable Architectures.

Image Processing

Processing Images: Introduction, gray level scaling transformations, equalization, geometric image and interpolation, Smoothing, transformations, edge detection, Laplacian and sharpening operators, line detection and template matching, logarithmic gray level sealing, the statistical significance of image features. Applications of pattern recognition, statistical decision theory, image processing and analysis. Probability: Introduction, probability of events, random variables, Joint distributions and densities, moments of random variables, estimation of parameters from samples, minimum risk estimators Statistical Decision Making: Introduction, Bayes' Theorem, multiple features, conditionally independent features, decision boundaries, unequal costs of error, estimation of error rates, the leaving-one—out technique. Characteristic curves, estimating the composition of populations. Nonparametric Decision Making: Introduction, histograms, Kernel and window estimators, nearest neighbor classification techniques, adaptive decision boundaries, adaptive discriminate Functions, minimum squared error discriminate functions, choosing a decision making technique. Clustering: Introduction, hierarchical clustering, partitional clustering Artificial Neural Networks, PCA, ICA, SVM.

Reference books

1. *Eart Gose, Richard Johnsonburg and Steve Joust, "Pattern Recognition and Image Analysis", Prentice-Hall of India.*

2. *Duda and Hart, "Pattern recognition (Pattern recognition a scene analysis)".*

Instrumentation Communication Protocols

Networks in process automation, flow requirements, Hierarchical communication model, Data Communication, OSI reference model, Industry Network, Recent networks. Communication Protocols, Network Classification, Device Networks, Control Networks, Enterprise Networking, Network selection. Proprietary and open networks, Architectures, Building blocks, Industry open protocols (RS-232C, RS-422, RS-485), Ethernet, Modbus, Modbus Plus, Data Highway Plus, Advantages and Limitations. Fieldbus, Trends, Hardware selection, Fieldbus design, Installation, Documentation, Advantages and limitations. HART, Design, Installation, calibration, commissioning, Application in Hazardous and Non-Hazardous area. Foundation Fieldbus & Profibus, Design, Calibration, Commissioning, Applications. Wireless Protocols, WPAN, Wi-Fi, Bluetooth, ZigBee, Z-wave.

Reference books

1. B.G. Liptak, "Process Software and Digital Networks", CRC Press.

2. Romilly Bowden , "HART Communications Protocol ', Fisher-Rosemount.

Power Quality Management

Importance of power quality, terms and definitions of power quality as per IEEE std. 1159. Symptoms of poor power quality, Purpose of groundings, grounding practices. Flickers & transient voltages, RMS voltage variations, complex power, voltage regulation, Basic power flow and voltage drop, devices used, reactive power management, causes of voltage flicker and effects, means to reduce flickers, Transient over voltages, control of transient voltages. Voltage sag, swells and interruptions, Economic impact, sag characteristics, assessment, fault location, vulnerability, equipment sensitivity to sags, CBEMA, ITIC, SEMI F 42 curves, sags analysis, sag indices, Mitigation. Waveform Distortion, harmonics, fourier analysis, non-sinusoidal conditions, Triplen harmonics, resonances, controlling, K-rated transformer, filtering, IEEE standard. Power quality monitoring, Initial site survey, Instrumentation, discrete monitoring, transducers. Power Quality Assessment & Mitigation, quality indices, standards, disturbances, unbalances, assessment under waveform distortion conditions, state estimation, State variable model, observability analysis, capabilities of harmonic state estimation, Test systems.

Reference books

1. M. H. J. Bollen, "Understanding power quality problems, voltage sag and interruptions", IEEE press.

2. Pogei C. Dugan, Mark F. McGranghan, Surya santoso, H. Wayne Beaty, "Electrical power system quality", McGraw Hill.

CMOS IC Design

MOS Switch, MOS Diode/Active Resistor, Current Sinks & Sources, Current Mirror, Current & Voltage Reference, Band gap References. Inverters, Differential Amplifiers, Cascode Amplifiers, Current Amplifiers, Output Amplifiers, High Gain Amplifier Architectures. Buffered Opamp, High Speed/Frequency Opamps, Differential Output Opamps, Micro power Op amps, Low Noise Opamp. Low Voltage Opamp, Macro models for Opamps. Sequential Ckts. Design of FSM, Moore & Mealy machines, Metastability, Solutions to metastability, Synchronization methods, VHDL codes for complex sequential machines, Hazards, Types of hazards, Method to eliminate hazards, case studies. CMOS parasitic, Technology scaling, Lambda parameter, Design calculations for different logic ckts, Calculations for Area on chip, Power dissipation, PDP, Transmission gate, Domino logic, NORA logic, CMOS layout techniques, Transient response, Advance trends of elements & Alloys for ultra fast logic ckts.

Reference books

1. Yusuf Leblebici, "CMOS Digital IC".

2. Douglas Holberg, "CMOS Analog circuit design", Oxford Publication.

Power System Protection

Introduction , numerical relay, sampling theorem, correlation with a reference wave, LES technique, digital filtering, numerical overcurrent protection. Digital Protection of Transmission line, distance relays, traveling wave relays, scheme based upon fundamental signal, hardware-software design, protection of EHV/UHV transmission line based upon traveling wave phenomenon, new relaying scheme using amplitude comparison. Digital protection of Synchronous generator. Digital Protection of Power Transformer. Distance and overcurrent relay setting and co-ordination Directional instantaneous IDMT overcurrent relay, directional multizone distance realy, distance relay setting, co-ordination of relays, graphics display, man-machine interface subsystem, integrated operation of national power system, application of computer graphics. Algorithm for S.C. studies, PC based integrated software, multiphase systems. Ultra high speed protective relays for high voltage long transmission line.

Reference books

1. L. P. Singh, "Digital Protection", New Age International (P) Limited Publishers.

2. Paithankar, "Transmission Network Protection", Marcel & Dekker.

Transducers and Designs

Review of Transducers for measurement of Physical parameters i.e. displacement, pressures, force, Flow, stress, strain, velocity, vibration, torque, temperature, pH, conductivity, proximity, Chemical parameters, Biomedical parameters i.e. pathological parameters, alpha-beta-gamma radiation. Signal conditioners, Strain Gauge Transducers, Inductive Transducers, Magnetic, Magneto-strictest, Piezo Electric Transducers, Optical Transducers, Capacitive Transducers, Vibrating wire. Processors for Analogue and Digital Signals, Input and Output Display Systems. Design of Electromechanical Transducers for: Force, Pressure, Stress, Vibration using Strain-gauge, LVDT, Capacitive Elements, Optical Device, Case studies. Design of Electromechanical Transducers for Torque, Flow and Velocity. Case studies. Rotation and Gyration of Machinery like Winches, Earth Movers, Fork lifts, Giant Wheels, Space Craft etc. Multi-output Transducers. Case Studies for: Chemical Sensors, Bio sensors, Gas Sensors, Nano Sensors and MEMS applications. LASER for measurements, micromachining, printing.

Reference books

1. H K P Neubert, "Instrument Transducers", Oxford University Press.

2. Bella G Liptak, "Instrument Engineer Handbook", CRC Press.

Wave Theory and Microwave Circuits

Basic concepts in RF design: Nonlinearity and time variance, inter-symbol interference, random process & noise, definition of sensitivity and dynamic range, conversion gain and Distortion. Solid state devices: microwave semiconductor devices and models, PIN, Tunnel, varactor, schottky diodes, IMPATT and TRAPATT devices, transferred electron devices, Microwave BJTs, GaAs FETs, MESFET, MOSFET, HEMT and CCDs. Amplifiers: Power gain equations, stability, impedance matching, constant gain and noise figure circles, small signal, low noise ,high power and broadband amplifier design, oscillators, Mixers. Wave guide and planar antenna. Review of electromagnetic radiation, antenna basic concept and related definitions, formulation of radiation integrals and its applications to analysis of wire, loop and helix type antenna, Micro-strip antenna, rectangular and circular patch, feeding methods, circularly polarized micro-strip antenna. Linear arrays.

Reference Books:

1. *S.Y. Liao, "Microwave circuit Analysis and Amplifier Design", Prentice Hall.*
2. *J.D.Kraus, "Antennas", Mc-Graw Hill.*

Multi resolution Analysis

Discrete Fourier transform, , sub band coding and multiresolution analysis, wavelet transform, Discrete wavelet transform, Introduction to time frequency analysis; the how, what and why about wavelets, wavelet functions: Harr scaling functions, Harr wavelet function, orthogonality & normalization, wavelet compression. Background of Image processing: digitized image & its properties, basic concepts, image digitization, brightness adaption and discrimination, colour representation, statistical background, Image representation, Image formats. Image enhancement by point operations, spatial frequency & Fourier frequency methods, colour image processing, image segmentation & representation. Introduction to time frequency analysis Different families of wavelets, Vector space Continuous time bases and wavelets, multiresolution analyisis,, mathematical preliminaries, windowed Fourier transform, short-time Fourier transform, properties of continuous wavelet transform; Idea of multiresolution, Harr as a basis for L2 (R), Wavelet packet analysis Harr wavelet packets, application to signal and image compression, Transform coding, DTWT for image compression, Audio compression, Edge detection and object isolation, Image fusion, Scaling functions as signaling pulses, Multi tone modulation, image enhancement, feature extraction.

References books :

1. *Insight into wavelets (from theory to practice by K P Soman, K I Ramchandran PHI publication (2nd edition)*
2. *Wavelet transform –introduction to theory & application By Rao & Bopardikar Pearson Publication*
3. *Fundamentals of Electronic Image Processing by Arthur R. Weeks, Jr., Prentice – Hall, India. .*
4. *Wavelet Analysis –by Springer Publication*
5. *Ten lectures on wavelets –by Daubechies I (CBMS-NSF, SIAM, 1982)*
6. *Data compression book by Nelson BPB Publication*
7. *Data Compression book by Khalid Sayood Morgan Kaufmann Publishers*

Audio and Video Coding standards

Information and Source Coding for discrete sources: Mathematical models for Information, A Logarithmic Measure of Information: Average and Mutual Information, Entropy, Coding for Discrete Sources-Coding for Discrete Memory-less Sources, Discrete Stationary Sources, Shanon-Fano & Huffman algorithms, Arithmetic coding, transform based lossy coding, DCT, Quantization, JPEG standard and its modes, Color image coding, B/W and color Television standards, Video compression, motion estimation and compensation, block matching algorithms and criteria, MPEG standard-1, 2, 4, Audio coding, psychoacoustic models, ADPCM , MPEG-Audio, Dolby Audio,
Channel coding, Channel models, Channel capacity, Linear block codes, Error correction and detection capability, Usefulness of the standard array, Cyclic codes, Block codes examples such as Hamming codes Convolutional codes, Convolutional encoding and decoding algorithms such as Viterbi, Sequential and feedback, RS codes and turbo codes

References :

1. *Bhaskaran, Image and Video Compression standards and Algorithms, Kluwer Academic press*
2. *Bernard Sklar, "Digital Communication: Fundamentals and Applications", Pearson Education Asia.*
3. *Simon Haykins, "Digital Communication", edition II, Wiley.*
4. *B.P.Lathi, "Modern Digital and Analog Communication Systems", edition III, Oxford press*
5. *Gulati, Television Engineering, PHI*

Mobile Communications

Introduction to cellular mobile systems, Mobile radio propagation path loss and fading, Diversity schemes, Combining Techniques, Mobile radio interference, co-channel and adjacent channel interference, Cellular system concept, frequency reuse, hand offs, Multiple access techniques, Analog & Digital modulation techniques for mobile radio, Signaling, Control & connection to fixed networks, Wireless networking, Differences between wireless and fixed telephone networks, Design considerations at Base station , Design considerations at mobile unit, Wireless system examples like GSM,CDMA (IS 95) and their architecture.

References books:

1. *William C.Y.Lee , Mobile Cellular Telecommunications Analog and digital systems, Second Edition, Mc Graw Hill*
2. *William C.Y.Lee , Mobile Communications Engineering theory and Applications, Second Edition, Mc Graw Hill*
3. *Jochen Schiller, Mobile Communications, Second Edition, Pearson*
4. *T.S.Rappaport ,Wireless Communications, Second Edition, Prentice-Hall*
5. *Pahlavan,Krishnamurthy, Prnciples of Wireless Networks, Prentice-Hall*

Optical Communication and Networks

Overview of Optical fiber Communication, Optical fibers Structures and Wave guiding, Signal degradation in optical fibers, Optical Sources, Photo detectors, Optical receiver operations, Digital Links. Wavelength Division Multiplexing: concepts and components.

Optical Networks: Network concepts, Topologies, SONET/SDH, High speed light wave links, Optical Add /Drop Multiplexing, Design issues in WDM Optical Network, Optical switching, WDM network examples, Wavelength Routing Algorithms, Next generation Optical Internet Networks, IP over ATM, IP over SONET, Overlay and Integrated models for IP/WDM networks.

References books:

1. *Optical Fiber Communication by Gerd Keiser, TMH, 4/e.*
2. *WDM Optical Networks: Concepts Design, and Algorithms by C. Siva Ram Murthy and Mohan Gurusamy, PHI, EEE.*

VLSI in Signal Processing

Typical DSP algorithms and representation : DCT, DWT and filter banks, Vector Quantization, Block diagram, signal flow graph, data flow graph and dependence graph. DSP application demands and CMOS technologies, Loop bound and iteration bound and their computation, Pipelining and Parallel Processing: Pipelining of FIR Digital filters, parallel FIR digital filters, combined pipelining and parallel processing. Retiming, Properties of retiming, Retiming techniques for clock minimization and register minimization. Unfolding, properties and applications of unfolding. Folding, 2D Systolic arrays and matrix multiplication, Bit level arithmetic architectures: Parallel multipliers, Baugh Wooley carry save multiplier, Booth Wallace Tree multipliers, Bit serial multipliers, Bit serial FIR filter. Carry free radix-2 addition and subtraction, Floating point arithmetic, Clocking for synchronous pipelining and wave pipelining systems, Clock distribution, Floor planning. FPGA architectures: block memories, CLBs, IOBs, Routing resources, specific resources like MAC, DLL, clock managers etc.

References books:

1. *"VLSI Digital Signal Processing Systems, Design and Implementation" by Keshab Parhi, John-Wiley & sons.*
2. *"Principles of CMOS VLSI Design", by Neil H.E.Weste, Kamran Eshraghian, Pearson Education.*
3. *"Digital Systems Desoign Using VHDL", by Charles Roth, Jr. Thomas Learning.*
4. *"Design Warriors guide to FPGAs" by C.M Maxfield, Newness.*
5. *"Digital Signal Processing with Field Programmable Gate Arrays", U.Meyer-Baese, second edition Springer.*

Statistical Signal Analysis and Stochastic Processes

Signals and Systems: System theory, stochastic process and their representation, Gauss – Markov models, likelihood and efficiency. Detection theory: Hypothesis testing, Decision criterion, multiple measurements, multiple and composite hypothesis system, CFAR detection. Detection of signals in noise: detection of known signals in white noise, co- relation receiver, Maximum SNR criterion Estimation theory: Estimation of parameters, random and non-random, Bayer's estimates, properties of estimators, linear mean square estimation. Estimation of waveform: Linear MMSE estimation of waveform, estimation of stationary process, Weiner filters, estimation of non- stationary process, Kalman filters. Relation between Weiner filters and Kalman filters, non-linear estimation. Application to RADAR signal processing, estimation of range Detection of object, it's size etc. Linear prediction and optimum linear filters: Forward and backward linear prediction, properties of linear prediction error filters, AR lattice and ARMA lattice ladder filters, Weiner filters for filtering and prediction

References books:

1. *Srinath, Rajeskaran, Introduction to statistical signal processing with application, PHI- Pearson Publication*
2. *John Proakis, Digital Signal Processing. PHI Pearson Publication*
3. *Papoulis, Probability Theory and Random Variables, PHI*
4. *Henry Stark and John Woods, Probability and Random Processes with Applications to Signal Processing, Pearson Education*

Optimal Control Systems

Introduction. static and dynamic optimization. Parameter optimization, Calculus of Variations : problems of Lagrange, Mayer and Bolza. Euler-Language equation and transversality conditions, Lagrange multipiliers, Pontryagins maximum principle; theory; application to minimum time, energy and control effort problems, and terminal control problem, Dynamic programming : Belamans principle of optimality, multistage decision processes. application to optimal control, Linear regulator problem : matrix Riccati equation and its solution, tracking problem, Computational methods in optimal control. application of mathematical programming. singular perturbations, practical examples.

References books:

1. *D.E.Kirk, Optimal Control Theory, Prentice-Hall. 1970.*
2. *A.P.Sage and C.C.White II, Optimum Systems Control, 2nd ED., Prentice-Hall, 1977.*
3. *D.Tabak and B.C.Kuo, Optimal Control by Mathematical Programming, Prentice-Hall, 1971.*
4. *B.D.O. Anderson and J.B.Moore, Linear Optimal Control, Prentice-Hall, 1971.*

High Power Electronic Devices

Basic device models: Theory of bipolar and MOS transistors. Small-signal models of bipolar and MOS transistors, Gummel-Poon model, High current effects in diodes: Dependence of lifetime on high-level injection, non-uniform current distribution under high current injection, Power biploar transistors: Onset of high-current effects in transistors; Theories of Kirk effect, crowding, pinch-in effects, second breakdown, etc; Emitter geometries for high current and HF operation, SCR : Theories of operation; Relation between shorted emitter and dv/dt ratings; Gate turn-off devices, inverter grade SCRs, special diffusion techniques for SCRs. Power VMOS devices, Heat transfer in power devices; Power MOS devices : VMOS & DMOS device structure and models; device packaging.

Reference books:

1. *S.M. Sze, Physics of Semiconductor Devices, 2nd ed., Wiley, 1981.*

Antennas and radiating Systems

Types of Antennas: Wire antennas, Aperture antennas, Micro strip antennas, Array antennas Reflector antennas, Lens antennas, Radiation Mechanism, Current distribution on thin wire antenna, Fundamental Parameters of Antennas: Radiation Pattern, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna efficiency, Beam efficiency, Bandwidth, Polarization, Input Impedance, radiation efficiency, Antenna Vector effective length, Friis Transmission equation, Antenna Temperature, Linear Wire Antennas: Infinitesimal dipole, Small dipole, Region separation, Finite length dipole, half wave dipole, Ground effects. Loop Antennas: Small Circular loop, Circular Loop of constant current, Circular loop with non uniform current, Linear Arrays: Two element array, N Element array: Uniform Amplitude and spacing, Broadside and End fire array, Super directivity, Planar array, Design consideration, Aperture Antennas: Huygen's Field Equivalence principle, radiation equations, Rectangular Aperture, Circular Aperture. Horn Antennas: E-Plane, H-plane Sectoral horns, Pyramidal and Conical horns, Micro strip Antennas: Basic Characteristics, Feeding mechanisms, Method of analysis, Rectangular Patch, Circular Patch. Reflector Antennas: Plane reflector, parabolic reflector, Cassegrain reflectors.

References books:

1. *Constantine Ballanis: Antennas Theory Analysis and Design 2/e: Wiley.*
2. *John D Krauss : Antennas :TMH*

Machine Vision and Pattern Analysis

Introduction- purpose, state of the art Image Formation - image sensors , projection, color Geometric Calibration- interior and exterior calibration, rectification, Stereo imaging and motion- epipolar geometry, correspondence, triangulation , detection and tracking of point features, optical flow Object Tracking Kalman filter, condensation, tracking humans Object Tracking Kalman filter, condensation, tracking humans, Non-visible-light Imagery- processing of non visible light images and depth images, Applications of computer vision - Fingerprint or iris recognition system , tomography , automatic reading of license plates , Industrial robot vision etc

References books:

1. *Ballard and Brown. "Computer Vision." Prentice Hall.*
2. *Forsyth and Ponce, Computer Vision: A Modern Approach, Prentice Hall*

Systems on Chip

IC Technology, Economics, CMOS Technology overview, Power consumption, Hierarchical design, Design Abstraction, EDA tools. MOSFET model, parasitics, latch up, advanced transistor structures; Wire parasitics; Design rules, Scalable design rules, process parameters; stick diagrams, Layout design tools; Layout synthesis, layout analysis. CMOS gate delays, transmission time, speed power product, low power gates; Delay by RC trees, cross talk, RLC delay, cell based layout, Logic & interconnect design, delay modeling, wire sizing; Power optimization, Switch logic networks. Pipelining, Data paths, Adders, ALUs, Multipliers, High density memories; Metastability, Multiphase clocking; Power optimization, Design validation, Sequential testing; Architecture for low power. Floor planning methods, global routing, switch box routing, clock distribution; off chip connections, packages, I/O architectures, pad design. Complete chip design including architecture, logic and layout for Kitchen timer chip OR Microwave oven chip

Reference books:

1. *Wayne Wolf, "Modern VLSI Design", Pearson Education.*
2. *Kamaran Eshraghian, "Principles of CMOS VLSI Design", Pearson Education*
3. *Rabey, Chandrakasan, "Digital IC Design", Pearson Publication*

Applied Linear Algebra

Vector spaces, linear dependence, basis; Representation of linear transformations with respect to a basis, Inner product spaces, Hilbert spaces, linear functions; Riesz representation theorem and adjoints, Orthogonal projections, products of projections, orthogonal direct sums; Unitary and orthogonal transformations, complete orthonormal sets and Parseval's identity; Closed subspaces and the projection theorem for Hilbert spaces, Polynomials: The algebra of polynomials, matrix polynomials, annihilating polynomials and invariant subspaces, Jordan forms, Applications: Complementary orthogonal spaces in networks, properties of graphs and their relation to vector space properties of their matrix representations; Solution of state equations in linear system theory; Relation between the rational and Jordan forms, Numerical linear algebra: Direct and iterative methods of solutions of linear equations; Matrices, norms, complete metric spaces and complete normal linear spaces (Banach spaces); Least squares problems (constrained and unconstrained); Eigenvalue problem.

References books:

1. *K. Hoffman and R. Kunze, Linear Algebra, Prentice-Hall (India), (1986).*
2. *G.H. Golub and C.F. Van Loan, Matrix Computations, North Oxford Academic, 1983.*
3. *G. Bachman and L. Narici, Functional Analysis, Academic Press, 1966.*
4. *E.Kreyszig, ntroductory functional analysis with applications John Wiley, 1978.*