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	MMaths	Mathematics for Technology	3	√	
2	EEC2	Internet of Things	3	√	
3	EEC3	Advanced Digital Signal Processing	3	√	
4	EEC4	Advanced Robotics	3	√	
5	EEE*	Elective-1	3	√	
6	EELP1	Lab Practice - 1	3		√
7	EESM1	Seminar - 1	1		√
Semester (II)					
8	EEC5	Communication Networks	3	√	
9	EEC6	Analytical Instrumentation	3	√	
10	ML	Machine Learning	3	√	
11	EEEC8	Computer Vision	3	√	
12	EEE*	Elective-2	3	√	
13	EELP2	Lab Practice - 2	3		√
14	EESM2	Seminar - 2	1		√
Semester (III)					
15	TSD	Technical Skill Development	3	√	
16	EED	Elective 6 /DS(Directed Study)	3	√	
17	EEIntProj	Interim Project	10		√
Semester (IV)					
18	EEFinProj	Final Project (Dissertation Submission)	16		√
		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	I
3	HRE102/HRE103	Human Rights & Vulnerable Groups/Law Policy , Society & Enforcement mechanism	1	II

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	EEE17	Engineering Ethics
17	EEE18	Antenna and radiating System
18	EEE19	Machine Vision and Pattern Analysis
19	EEE20	System on Chip
20	EEE21	Applied Linear Algebra
21	EEE22	Energy Auditing and Conservation

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

45	EEE49	Embedded System Design and Modelling
46	EEE50	Mechatronics and Transducers
47	EEE51	Modeling and Simulation
48	EEE52	Intellectual Property Rights
49	EEE53	Control Systems and Drives
50	EEDS1	Analog & Digital CMOS VLSI Design
51	EEDS2	Discrete-time Signal Processing System
52	EEDS3	Adv. Lithography
53	EEE53	Control Systems and Drives
54	EEDS4	Advanced Wireless Sensor Network and MSA
55	EEDS5	GPU Computing and Machine Learning
56	EEDS6	Engineering Optimization
57	EEDS7	Image Processing and Pattern Recognition

Program Education Objectives (PEOs)

Post Graduates will demonstrate ability to:

1. Address and tackle the real-world technological issues, develop and produce the cost-effective products, which meets the societal demands while demonstrating a strong foundation in Electronics and Electrical Technology.
2. Demonstrate excellence in business, higher education, and industry/technical professions while demonstrating global competitiveness.
3. Exhibit strong moral character, ethical behaviour, cooperation, transdisciplinary thinking, and the capacity to connect technical problems to broader social contexts.

Program Outcomes (POs)

Post Graduates of Electronics and Electrical Technology by the time of post-graduation will demonstrate:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems one step ahead of bachelor's capability.

PO2: Problem analysis: Review research literature, address issues, formulate problems, and analyse them, with substantial conclusions using first principles of mathematics and technology.

PO3: Design/development of solutions: Design and develop the system and its components that satisfies the specific need with necessary safety needs.

PO4: Conduct investigations of complex problems: Implements the research-based knowledge and methods including design of experiments, analysis and interpretation of data.

PO5: Modern tool usage: Predicts the models and create methods with appropriate resources, tools and software for various activities.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program specific outcomes

PSO 1: Development of Hardware/Software Co-designs: An ability to apply electronic design principles in the development of hardware/software prototypes and systems with progressive depth of complexity.
PSO 2: Development of Electronics Communication Systems: An ability to deploy conventional & next-gen. techniques/tools for analysis & design of Information and Communication systems.
PSO 3: Development of Signal Processing Applications: An ability to apply algorithmic knowledge of signal processing towards analysis, Recognition, and synthesis of multi-dimensional data.

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 PublisherCompany.

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.

Course Outcomes

1. Apply elementary transformations to reduce the matrix into the echelon form and normal form to determine its rank and interpret the various solutions of system of linear equations
2. Identify the special properties of a matrix such as the eigen value, eigen vector, employ orthogonal transformations to express the matrix into diagonal form, quadratic form and canonical form
3. Equip themselves familiar with the functions of several variables and mean value theorems
4. Familiarize with special functions to evaluate some proper and improper integrals using beta and gamma functions

S.P.Pune University

Department of Technology

SYLLABUS FOR MTech- Integrated MTech-PhD (Electronics and Electrical Technology)

INTERNET OF THINGS (IOT)

Course Code:EEC2 **Credit Units: 03**

Course Objective:

The Internet is evolving to connect people to physical things and also physical things to other physical things all in real time. It's becoming the Internet of Things (IoT). The course enables student to understand the basics of Internet of things and protocols. It introduces some of the application areas where Internet of Things can be applied. Students will learn about the middleware for Internet of Things. To understand the concepts of Web of Things

Course Contents:

Module I: IOT - What is the IoT and why is it important? Elements of an IoT ecosystem, Technology drivers, Business drivers, Trends and implications, Overview of Governance, Privacy and Security Issues.

Module II: IOT PROTOCOLS - Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Issues with IoT Standardization – Unified Data Standards – Protocols – IEEE802.15.4–BACNet Protocol– Modbus – KNX – Zigbee– Network layer – APS layer – Security

Module III: IOT ARCHITECTURE - IoT Open source architecture (OIC)- OIC Architecture & Design principles- IoT Devices and deployment models- IoTivity : An Open source IoT stack - Overview- IoTivity stack architecture- Resource model and Abstraction.

Module IV: WEB OF THINGS - Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization for WoT– Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals and Business Intelligence.

Module V:IOT APPLICATIONS - IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, IoT- A, Hydra etc.

Text & References:

Text:

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press,2012.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
3. David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", Cambridge University Press, 2010.

4. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012.

References:

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)",1st Edition, VPT, 2014
2. Francis da Costa, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013
3. CunoPfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-4493-9357-1

Course Objective:

To impart the knowledge of design features, data handling, data communication, data networking and design issues of IoT.

Course Outcomes:

Students will be able to:

1. Identify and describe the need and evolution of Internet of Things
2. Describe working principle IOT sensors and actuators
3. Explain working principle of on-board peripherals, analyze various protocols for IoT
4. Describe the specifications of IOT components from data sheet
5. Develop web services to access/control IoT devices.
6. Design a portable IoT using Rasperry Pi
7. Deploy an IoT application and connect to the cloud.
8. Analyze applications of IoT in real time scenario

Advanced Digital Signal Processing

Course Code:EEC3 **Credit Units: 03**

Course Contents:

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, Multi-rate DSP, Sampling rate conversion, poly-phase 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 & Multi-rate 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, Macmillanpublishing*

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*

Course Outcome:

1. Identify and formalize architectural level characterization of P-DSP hardware.
2. Ability to design, programming, and testing code for DSP applications using CodeComposer Studio environment in simulation mode and using starter kits.
3. Deployment of DSP hardware for Control, Audio and Video Signal processing applications.
4. Multirate and Adaptive Signal Processing
5. Evaluate the performance of various methods for designing adaptive filters through estimation of different parameters of stationary random process.
6. Ability to experiment and identify merits and demerits of various adaptive algorithms.
7. Design and implement filtering solutions for various applications

ADVANCED ROBOTICS

Course Code:EEC4 **Credit Units: 03**

Course Objective: The course aims to introduce the working of robots their geometric interpretations and planning of trajectories.

1. To introduce the functional elements of Robotics
2. To impart knowledge on the direct and inverse kinematics
3. To introduce the manipulator differential motion and control
4. To educate on various path planning techniques
5. To introduce the dynamics and control of manipulators.

Course Contents:

Robot Arm Kinematics Introduction.The Direct Kinematics Problem.Rotation Matrices, Composite Rotation Matrix. Rotation Matrix about an Arbitrary Axis, Rotation Matrics with Euler Angles Representation, Geometric Interpretation of Rotation Matrics, Homogeneous Coordinates and transformation Matrix. Geometric Interpretation of Homogeneous Transformation Matrices, Composite Homogeneous Transformation Matrix. II&III Links, Joints and Their Parameters, The David-Hhartenberg Representation, ½ Kinematics Equation for Manipulators, Other specifications of the Location of the End-Effector, Classification of manipulators, The Inverse Kinematics Problem, Inverse Transform Technique for Euler Angles Solution. Planning of Manipulator Trajectories Introduction, General considerations on Trajectory planning, joint- Interpolated Trajectiries, Calculation of a 4-3-4 joint Trajectory, Cubic Spline Trajectory (five Cubics).Measurement systems,

Control systems, Microprocessor- based controllers, Response of systems, EEE2t and chain drives,Electrical Actuation Systems: Electrical systems, Mechanical switches, Solid state switches, Solenoids, D.C. Motors, A.C. Motors, Stepper Motors. Programmable Logic Controllers: Introduction, Basic Structure, Input Output Processing, Programming, Mnemonics, Timers, Internal Relays and Counters, Shift Registers, Master and jump controls, Data handling, Analogue input/output, Selection of a PLC. Mechatronics Systems: Traditional and Mechatronics Designs, Possible Mechatronics Design Solutions, Case Studies of Mechatronic Systems

Text & References:

Text: • Robotics, Control, Sensing, Vision and Intelligence, K S FU

• R C GONZALEZ, C S G LEE, McGraw Hill, 1987.

References:

1. Introduction to Robotic Mechanics and Control, JOHN J. CRAIG, Pearson Education Ltd.
2. Introduction to Robotics, SYED V NIKU, PHI, Pearson, 2003
3. Robotics and Control, R K Mittal, I J Nagrath, TMH, 2003

Course Outcome:

1. Ability to understand basic concept of robotics.
2. To analyze Instrumentation systems and their applications to various
3. To know about the differential motion add statics in robotics
4. To know about the various path planning techniques.
5. To know about the dynamics and control in robotics industries.

Communication Networks

Course Code: EEC5 **Credit Units: 03**

Course Objective:

This course is intended to provide an in-depth and practical understanding of modern computer networks that constitute the Internet. The scope includes network architecture, key technologies, layer 2 and layer 3 protocols, and examples of specific systems. Emphasis will be on network protocols and related software implementation. The course includes a hands-on “clean-slate” network prototyping project involving specification, standardization and software implementation.

Course Contents:

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.*

Course output:

1. Apply Monte Carlo simulation, Discuss Lower Layer and Link Layer Wireless Modeling
2. Compare channel modeling and mobility modeling
3. Explain digital signature standards and discuss authentication
4. Explain security at different layers

Analytical Instrumentation

Course Code: EEC6 **Credit Units: 03**

Course Contents:

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.*

Machine Learning

Course Code: ML **Credit Units: 03**

Course Contents:

Motivation and role of machine learning in computer science and problem solving, Representation (features), linear transformations, Appreciate linear transformations and matrix vector operations in
the context of data and representation. Problem formulations (classification and regression), Appreciate the probability distributions in the context of data, Prior probabilities and Bayes Rule, Introduce paradigms of Learning (primarily supervised and unsupervised), PCA and Dimensionality Reduction, Nearest Neighbours and KNN,) Linear Regression, Decision Tree Classifiers, Notion of Generalization and concern of Overfitting, Notion of Training, Validation and Testing, Connect to generalization and overfitting. Ensembling and RF , Linear SVM, K Means, Logistic Regression, Naive Bayes. Kernels (with SVM), Bayesian Methods, Generative Methods, HMM, EM, PAC learning

Suggested text books

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press (23 April 2020)

2. Tom M. Mitchell- Machine Learning - McGraw Hill Education, International Edition T3 Aurélien Géron Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, Inc. 2nd Edition

Reference Books

1. Ian Goodfellow, Yoshoua Bengio, and Aaron Courville Deep Learning MIT Press Ltd, Illustrated edition
2. Christopher M. Bishop Pattern Recognition and Machine Learning - Springer, 2nd edition
3. Trevor Hastie, Robert Tibshirani, and Jerome Friedman - The Elements of Statistical Learning: Data Mining, Inference, and Prediction - Springer, 2nd edition

Course Outcomes:

1. Understanding popular ML algorithms with their associated mathematical foundations for appreciating these algorithms.
2. Capability to implement basic algorithms using basic machine learning libraries mostly in python. Gainhands-on experience in applying ML to problems encountered in various domains. In addition, obtain exposure to high-level ML libraries or frameworks such as TensorFlow, PyTorch.

3. Make aware of the role of data in the future of computing, and also in solving real-world problems using machine learning algorithms.
4. Help connect real-world problems to appropriate ML algorithm(s) for solving them. Enable formulating real world problems as machine learning tasks.
5. Appreciate the mathematical background behind popular ML algorithms.
6. Ensure awareness about importance of core CS principles such as algorithmic thinking and systems design in ML

Computer Vision

Course Code: EEC8 **Credit Units: 03**

Course Objective:

1. To review image processing techniques for computer vision.
2. To understand shape and region analysis.
3. To understand Hough Transform and its applications to detect lines, circles, ellipses.
4. To understand three-dimensional image analysis techniques.
5. To understand motion analysis.
6. To study some applications of computer vision algorithms.

Course Contents:

Computer and Human Vision Systems. The Human Eye, Computer versus Human Vision Systems, Evolution of Computer Vision, Computer/Machine Vision and Image Processing, Applications of Computer Vision. Computer Vision System, Computer Vision Camera: CCD and CMOS Image Sensors, TDI Sensor, Camera Type - Area Scan Cameras, Line Scan Cameras, Smart Cameras, Camera Lens Resolution, Contrast and Sharpness, Lenses and their parameters: Types of Lenses, Lens Mounts, Lens Selection Examples-Field of View Much larger than Camera sensor size or Smaller or close to Camera Sensor size, Machine Vision Lighting: Lighting: Light Sources in Computer Vision, Illumination Techniques-Backlighting, Front Lighting, Diffused Lighting, Oblique Lighting, Dark Field Lighting, Infrared and Ultraviolet Light, Filters, Computer Vision Software, Computer Vision Automation, Integration of Computer Vision Components, Digital Image Processing for Computer Vision Applications, Emerging Trends in Computer Vision. Applications in Computer Vision: Face detection, face recognition, eigen faces, car on roads, History of Industrial Revolution(s), Computer Vision and Industry 4.0, Emerging Vision Trends in Manufacturing, 3D Imaging, Emerging Vision Trends in Manufacturing,

Textbooks:

1. Sheila Anand and L.Priya , —A Guide for Machine Vision in Quality Control‖, Taylor & Francis Inc, Imprint CRC Press Inc, Dec 2019
2. Rafael C. Gonzalez and Richard E. Woods, —Digital Image Processing‖, Pearson
3. Carsten Stegar, Markus Ulrich, and Christian Wiedemann , —Machine Vision Algorithms and Applications‖,Second completely Revised and Enlarged Edition

4. Milan Sonka, Vaclav Hlavac, Roger Boyle, —Image Processing Analysis and Machine Vision‖, Second Edition, Cengage Learning.

References

1. Chiranji Lal Chowdhary, Mamoun Alazab, Ankit Chaudhary, SaqibHakak and Thippa Reddy Gadekallu ,‖Computer Vision and Recognition Systems Using Machine and Deep Learning Approaches, Fundamentals, technologies and applications‖ , IET COMPUTING SERIES 42
2. Joe Minichino Joseph Howse ,‖Learning OpenCV 3 Computer Vision with Python‖, Second Edition, Packt Publishing Ltd.
3. Alexander Hornberg,, — Handbook of Machine and Computer Vision The Guide for Developers and Users.

Course Outcomes:

1. Implement fundamental image processing techniques required for computer vision.
2. Perform shape analysis.
3. Implement boundary tracking techniques.
4. Apply chain codes and other region descriptors.
5. Apply Hough Transform for line, circle, and ellipse detections.
6. Apply 3D vision techniques.
7. Implement motion related techniques.
8. Develop applications using computer vision techniques.

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. ARM7/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.*

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.

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 chainingrules, 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 andfilter 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, Advancetrends 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 timefrequency 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, Chann elcoding, 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 GrawHill*

2. *William C.Y.Lee , Mobile Communications Engineering theory and Applications, Second Edition, Mc GrawHill*

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 WallaceTree 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, specificresources 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 : problemsof 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: Onsetof 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. HornAntennas: 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.*