Biju Patnaik University of Technology, Orissa

Rourkela

Syllabus

of

M.Tech

in

Electronics
&
Instrumentation Engineering

From 2009 -2010 Academic Session

Semester	Subject	Credit	Details of Subjects
I	EIPC101	4	Instrumentation Devices and Systems
	EIPC102	4	Process Dynamics and Control
	EIPC103	4	Analytical Instrumentation
		3	***Elective – I*** ***(any one)***
	EIPE101		Digital Instrumentation
	EIPE102		Industrial Automation and Robotics
	VLPC102		Digital Integrated Circuit Design
	CSPE102		Computational Intelligence
		3	**Elective – II** ***(any one)***
	ETPE101		Adaptive Signal Processing
	EIPE106		Statistical Signal Processing
	EIPE107		Digital and Adaptive Control
	EIPE108		Fibre-Optic and Laser Instrumentation
	EIPR101	4	Instrumentation Devices and Process Control Lab
	EIPT101	2	Seminar on Pre-thesis Work-1
Semester Credits:		**24**	
II	EIPC201	4	Control System Design
	EIPC202	4	Modeling and Simulation
		3	**Elective – III** ***(any one)***
	EIPE201		Virtual Instrumentation
	EIPE202		Communication Protocols in Instrumentation
	ETPE206		Industrial Telematics
		3	**Elective – IV** ***(any one)***
	EIPE204		Non-linear Systems
	EIPE204		Real Time Instrumentation
		3	**Elective – V** ***(any one)***
	EIPE205		PC Based Instrumentation
	ETPE203		Bio-Medical Instrumentation and Signal Processing
	VLPC201	4	Embedded System Design
	VLPE201	2	Microsystems – Principles, Design and Application
	EIPE206	2	Reliability Engineering
	EIPR201		Modeling and Simulation Lab

	EIET201 EICV201		Seminar on Pre-thesis work-2 Comprehensive Viva-Voce - I
Semester Credits:		**25**	

Semester	Subject	Credit	Details of Subjects
III	**Open Elective** **(any one)** **Thesis-1**	**3** **14**	Project Management / Project Costing / Technology Management / Research Methodology / Optimization Techniques / Computational Intelligence / Thesis – I
Semester Credits:		**17**	
IV	EIPT401 EICV401 EICV402	20 2 2	Thesis – II Seminar Comprehensive Viva-Voce – II
Semester Credits:		**24**	
Total Credits		**90**	

Instrumentation Devices and Systems

Module – I (12 Hours)
Chemical Sensors
Physical Sensors – Surface Micro Machined Capacitive Pressure sensor, Integrated flow sensor, Chemical and Biochemical Sensors – Conductivity sensor, Hydrogen Sensitive MOSFET, Tri-Oxide Sensors, Schottky diode type sensor, Solid Electrolyte, Electrochemical Sensors. Sensor Matrix for Two dimensional measurement of concentrations.

Module – II (14 Hours)
Optical Sensors
Holography, Echolocation and bio holography, Sensors used in space and environmental applications. Application in meteorology, natural resources application sensor used in Instrumentation methods.
Biomedical Sensors
Biological Sensors in Human Body – Different types of Transducer system – Physiological Monitoring – chemo receptors – Hot and cold receptors – sensors for smell, sound, vision taste.

Module – III (14 Hours)
Aerospace Sensor
Gyroscope laser and fibre optic gyroscopes, accelerometers. Laser, Aerospace application of laser, Resolvers, Altimeters, Angle of attack sensors, servos.
Advanced Sensor Design
Sensor design a sensor characteristics, Design of signal conditioning devices for sensors. Design of 2& 4 wire transmitters with 4 – 20 mA output. Pressure Sensor using SiSi bonding, Catheter pressure sensors, TIP pressure sensors, Highpressure sensors, Silicon accelerometers.

Textbooks:

1. *Sabaree Soloman, **Sensors Hand Book**, McGraw Hill, 1998.*
2. *J.G. Webster, **Medical instrumentation Application and Design**, Houghton Mifilin Co.*
3. *Carr and Brown, **Introduction to Medical Equipment Technology**, Addison Wesley, 1999.*

Recommended Reading:

1. *Culshaw B and Dakin J (Eds), **Optical Fibre Sensors**, Vol. 1 & 2, Artech House, Norwood, 1989.*
2. *P. Garnell, **Guided Weapon Control Systems**, Pergamon Press, 1980.*

Process Dynamics and Control

Module – I **(13 Hours)**

Design aspects of Process Control System

Classification of variables, Design elements of a control system, control aspects of a process. The input – output model, degrees of freedom and process controllers. Modes of operation of P, PI and PID controllers. Effect of variation of controller variables. Typical control schemes for flow, pressure, temperature and level processes.

Module – II **(13 Hours)**

Control System components:

I/P and P/I converters - Pneumatic and electric actuators - valve positioner - control valve Characteristics of control valve - valve body - globe, butterfly, diaphragm ball valves - control valve sizing - Cavitation, flashing in control valves - Response of pneumatic transmission lines and valves. Actuators – Pneumatic, Hydraulic, Electrical/ Electronic.

Module – III **(14 Hours)**

Dynamic behavior of feedback controlled process:

Stability considerations. Simple performance criteria, Time integral performance criteria: ISE, IAE, ITAE, Selection of type of feedback controller. Adaptive Control, Gain Scheduling Adaptive Control, Model – reference adaptive control, self tuning regulator. Logic of feed forward control, problems in designing feed forward controllers, feedback control, Ratio Control, Cascade Control.

Textbooks:

1. Curtis Johnson, ***Process Control Instrumentation Technology*****,** Prentice Hall of India.
2. George Stephanopoulos, ***Chemical Process Control*****,** Prentice Hall of India.
3. F.G. Shinkskey, ***Process Control Systems*****,** McGraw-Hill Publications.

Analytical Instrumentation

Module – I **(12 Hours)**

Introduction

Introduction to Chemical Analysis, Classical and Instrumental Methods, Classification of Instrumental Techniques, Important Considerations in Evaluating an Instrumental Method.

Absorption Methods

(a) Spectrometric UV and VIS Methods: Laws of Photometry, Instrumentation.
(b) IR Spectrometry: Correlation of IR Spectra with Molecular Structure, Instrumentation.
(c) Atomic Absorption Spectrometry: Principle, Instrumentation.

Emission Methods

Flame, AC/DC Arc, Spark, Plasma Excitation Sources, Instrumentation**.**

Module – II **(14 Hours)**

Spectro-Fluorescence and Phosphorescence Spectrometer

Instrumentation, Raman Spectrometer.

Mass Spectrometer

Ionization Methods, Mass Analyzers, Mass Detectors, FTMS.

Chromatography

Classification, Gas Chromatography, Liquid Chromatography, Instrumentation.

Module – III **(14 Hours)**

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

Principle, Chemical Shift, Spin-Spin Coupling, Instrumentation, Types of NMR.

Elector-Analytical Methods

Potentiometry, Voltammetry, Coulometry Techniques.

Textbooks:

1. *Galen W. Ewing,* ***Instrumental Methods of Chemical Analysis****, 5th Edition, McGraw-Hill.*
2. *Willard, Merritt, Dean and Settle,* ***Instrumental Methods of Analysis****, 7th Edition, CBS Publishers, New Delhi.*

Digital Instrumentation

Module – I **(11 Hours)**

Introduction

Digital Codes, Memory Devices, Basic Building Blocks: Gates, FF and Counters, Discrete Data Handling: Sampling, Sampling Theorem, Aliasing Errors, Reconstruction, Extrapolation, Synchronous and Asynchronous Sampling.

Digital Methods of Measurements

Review of A/D, D/A Techniques, F/V and V/F Conversion Techniques, Digital Voltmeters and Multimeters, Automation and Accuracy of Digital Voltmeters and Multimeters, Digital Phase Meters, Digital Tachometers, Digital Frequency, Period and Time Measurements, Low Frequency Measurements, Automatic Time and Frequency Scaling, Sources of Error, Noise, Inherent Error in Digital Meters, Hidden Errors in Conventional AC Measurements, RMS Detector in Digital Multimeters, Mathematical Aspects of RMS.

Module – II **(11 Hours)**

Digital Display and Recording Devices

Digital Storage Oscilloscopes, Digital Printers and Plotters, CDROMS, Digital Magnetic Tapes, Dot Matrix and LCD Display CROs, Colour Monitor, Digital Signal Analyser and Digital Data Acquisition.

Signal Analysis

Amplifiers, Filters, Transmitter, Receiver, Wireless Base and Mobile Station Test Sets, Noise Figures Meters, RF Network Analyser and High Frequency Signal Sources.

Module – III **(12 Hours)**

Current Trends in Digital Instrumentation

Introduction to Special Function Add-on Cards, Resistance Card, Input and Output Cards, Counters, Test and Time of Card and Digital Equipment Construction with Modular Designing, Interfacing to Microprocessor, Micro-controllers and Computers, Computer Aided Software Engineering (CASE) Tools, Use of CASE Tools in Design and Development of Automated Measuring Systems, Interfacing IEEE Cards, Intelligent and Programmable Instruments using Computers.

Textbooks:

1. Bouwens, A.J., ***Digital Instrumentation***, McGraw Hill, 1984.
2. John Lenk, D., ***Handbook of Micro-computer Based Instrumentation and Control***, PHI, 1984.

3. Doebelin, ***Measurement System, Application and Design***, McGraw-Hill, 1990.

Recommended Reading:

1. "***Product Catalogue***", Hewlet Packard, 1996.

Industrial Automation and Robotics

Module – I **(12 Hours)**

Basic Concepts

Definition and origin of robotics, Different types of robotics, Various generations of robots, Degrees of freedom, Asimov's laws of robotics, Dynamic stabilization of robots.

Power Sources and Sensors

Hydraulic, pneumatic and electric drives, Determination of HP of motor and gearing ratio, Variable speed arrangements, Path determination, Micro machines in robotics, Machine vision, Ranging, Laser, Acoustic, Magnetic, Fiber optic and tactile sensors**.**

Module – II **(12 Hours)**

Manipulators, Actuators and Grippers

Construction of manipulators, Manipulator dynamics and force control, Electronic and pneumatic manipulator control circuits, End effectors, Various types of grippers, Design considerations.

Module – III **(14 Hours)**

Kinematics and Path Planning

Solution of inverse kinematics problem, Multiple solution jacobian work envelop, Hill climbing techniques, Robot programming languages.

Case Studies

Multiple robots, Machine interface, Robots in manufacturing and non-manufacturing applications, Robot cell design, Selection of robot.

Textbooks:

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., ***Industrial Robotics***, McGraw-Hill Singapore, 1996.
2. Ghosh, ***Control in Robotics and Automation: Sensor Based Integration***, Allied Publishers, Chennai, 1998.

Recommended Reading:

1. S.R. Deb, ***Robotics technology and flexible Automation***, John Wiley, USA 1992.
2. C.R. Asfahl, ***Robots and Manufacturing Automation***, John Wiley, USA 1992.

3. R.D. Klafter, T.A. Chimielewski, and M. Negin, ***Robotic Engineering – An Integrated Approach***, Prentice Hall of India, New Delhi, 1994.

Digital Integrated Circuit Design

MODULE – I **(11 hours)**

Introduction, Design Metrics and Manufacturing Process:
A Historical Perspective, Issues in Digital Integrated Circuit Design, Quality Metrics of a Digital Design, Introduction to Manufacturing Process, Manufacturing CMOS Integrated Circuits, Design Rules – The Contract between Designer and Process Engineer, Packaging Integrated Circuits.

The Devices: Introduction, The Diode, The MOS(FET) Transistor, The Wire, Interconnect Parameters – Capacitance, Resistance, and Inductance, Electrical Wire Models, SPICE Wire Models

The CMOS Inverters and CMOS Logic Gates – the Static View: Introduction to CMOS Inverter, The Static CMOS Inverter – An Intuitive Perspective, Evaluating the Robustness of the CMOS Inverter, Introduction to Static CMOS Design, Complementary CMOS, Ratioed Logic, Pass-Transistor Logic

CMOS Inverter – the Dynamic View: Performance of CMOS Inverter: The Dynamic Behavior, Power, Energy, and Energy-Delay, Perspective: Technology Scaling and its Impact on the Inverter Metrics

MODULE – II **(11 hours)**

Dynamic CMOS Logic, Timing Metrics:
Dynamic CMOS Design, CMOS Logic Design Perspectives, Timing Metrics: Timing Metrics for Sequential Circuits, Classification of Memory Elements

Static and Dynamic Sequential Circuits: Static Latches and Registers, Dynamic Latches and Registers, Alternative Register Styles: Pulse Registers and Sense-Amplifier Based Registers, Pipelining: An Approach to Optimize Sequential Circuits – Latch Vs Register-Based Pipelines and NORA-CMOS – A Logic Style for Pipelined Structures, Nonbistable Sequential Circuits

Coping with Interconnect: Introduction, Capacitive Parasitics, Resistive Parasitics, Inductive Parasitics, Advanced Interconnect Techniques, Networks-on-a-Chip

Timing Issues in Digital Circuits: Introduction, Timing Classification of Digital Systems, Synchronous Design – An In-depth Perspective, Self-Timed Circuit Design, Synchronisers and Arbiters, Clock Synthesis and Synchronisation Using a Phase-Locked Loop, Future Directions and Perspectives

MODULE – III **(12 hours)**

Designing Arithmetic Building Blocks:
Introduction, Datapaths in Digital Processor Architecture, The Adder, The Multiplier, The Shifter, Other Arithmetic Operators, Power and Speed Trade-off's in Datapath Structures, Perspective: Design as a Trade-off

Designing Memory and Array Structures: Introduction, The Memory Core, Memory Peripheral Circuitry, Memory Reliability and Yield, Power Dissipation in Memories, Case Studies in Memory Design: The PLA, A 4-Mbit SRAM and A 1-Gbit NAND Flash memory, Perspective: Semiconductor Memory Trends and Evolution

Validation and Test of Manufactured Circuits: Introduction, Test Procedure, Design for Testability, Test Pattern Generation

Textbooks:
1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, ***Digital Integrated Circuits – A Design Perspective*****,** 2nd edn., Pearson Education, 2003. ISBN: 8178089912.

Recommended Reading:
2. K. Eshraghian, and N.H.E. Weste, ***Principles of CMOS VLSI Design – a Systems Perspective***, 2nd edn., Addison Wesley, 1993.

3. Wayne Wolf, ***Modern VLSI Design System – on – Chip Design***, 3rd edn., Pearson Education, 2003.
4. M. Michael Vai, ***VLSI Design***, CRC Press, 2001.
5. John P. Uyemura, ***CMOS Logic Circuit Design***, Springer (Kluwer Academic Publishers), 2001
6. Ken Martin, ***Digital Integrated Circuit Design***, Oxford University Press, 2000.

Computational Intelligence

Introduction to Soft Computing: Soft computing constituents and conventional Artificial Intelligence, Neuro-Fuzzy and Soft Computing characteristics.

Fuzzy Sets, Fuzzy Rules and Fuzzy Reasoning: Introduction, Basic definitions and terminology, Set-theoretic operations, MF Formulation and parameterization, More on fuzzy union, intersection, and complement, Extension principle and fuzzy relations, Fuzzy If-Then rules, Fuzzy reasoning.

Fuzzy Inference System: Mamdani fuzzy models, Sugeno Fuzzy Models, Tsukamoto fuzzy models, other considerations.

Least Square Method for system Identification: System Identification , Basic of matrix manipulations and calculus, Least-square estimator, Geometric interpretation of LSE, Recursive least-square estimator, Recursive LSE for time varying systems, Statistical Properties and maximum likelihood estimator, LSE for nonlinear models.

Derivative-based optimization: Descent methods, the method of steepest descent, Newton's methods, Step size determination, conjugate gradient methods, Analysis of quadratic case, nonlinear least-squares problems, Incorporation of stochastic mechanism.

Derivative-free optimization: Genetic algorithm simulated annealing, random search, Downhill simplex search, Swarm Intelligence, genetic programming.

Adaptive Networks: Architecture, Back propagation for feed forward networks, Extended back propagation for recurrent networks, Hybrid learning rule: combing steepest descent and LSE.

Supervised learning neural networks: Perceptions, Adaline, Back propagation multi layer perceptions, Radial Basic Function networks.

Learning from reinforcement: Failure is the surest path to success, temporal difference learning, the art of dynamic programming, Adaptive heuristic critic, Q-learning, A cost path problem, World modeling, other network configurations, Reinforcement learning by evolutionary computations.

Unsupervised learning and other neural networks: Competitive learning networks, Kohonen self-organizing networks, learning vector quantization, Hebbian learning, principal component networks, and the Hopfield network.

Adaptive Neuro-fuzzy inference systems: ANFIS architecture, Hybrid learning algorithms, Learning methods that cross-fertilize ANFIS and RBNF, ANFIS as universal approximator, Simulation examples, Extensions and advance topics.

Coactive Neuro-fuzzy modeling: towards generalized ANFIS: Framework, Neuro functions for adaptive networks, Neuro-Fuzzy spectrum, Analysis of adaptive learning capability.

Books:

1. *J.S.R. Jng, C.T. Sun and E. Mizutani,"Neuro-fuzzy and Soft Computing", PHI.*

2. S. Rajasekaran, G.A. Vijaylakshmi Pai,:Neural Networks, Fuzzy Logic, and Genetic Algorithms," PHI.

Adaptive Signal Processing

MODULE – I **(11 hours)**

Adaptive System

Definition and Characteristics, Areas of Application, Example of an Adaptive System, Adaptive Linear Combiner, The Performance Function, Gradient and Minimum Mean-Square Error, Alternative Expression of the Gradient, Decorrelation of Error and Input Components. [Read Widrow: Chapter 1 and 2]

Winer Filter

Linear Optimum Filtering, Principle of Orthogonality, Minimum Mean Square Error, Winer-Hopf Equation, Error Performance Surface. [Read Haykin: Chapter 2.1-2.5]

Linear Prediction

Forward Linear Prediction, Backward Linear Prediction, Properties of Prediction Error Filters. [Read Haykin: Chapter 3.1, 3.2, 3.4]

MODULE – II **(11 hours)**

Method of Steepest Descent

Basic Idea of Steepest-Descent Algorithm, Steepest-Descent Algorithm Applied to Winer Filter, Stability of Steepest-Descent Algorithm, Limitations of Steepest-Descent Algorithm. [Read Haykin: Chapter 4.1 – 4.3, 4.6]

Least-Mean Square Adaptive Filter

Overview, LMS Adaptation Algorithm, Application, Comparison of LMS With Steepest-Descent Algorithm. [Read Haykin: Chapter 5.1 – 5.3, 5.5]

Normalized Least-Mean Square Adaptive Filter

Normalized LMS Filter as the Solution to Constrained Optimization Problem, Stability of the NLMS. [Read Haykin: Chapter 6.1, 6.2]

MODULE – III **(11 hours)**

Frequency-Domain and Subband Adaptive Filters

Block Adaptive Filters [Read Haykin: Chapter 7.1]

RLS Adaptive Filters

Statement of Linear Least-Square Estimation Problem, Matrix Inversion Lemma, The Exponentially Weighted RLS Algorithm. [Read Haykin: Chapter 8.1, **9.1 – 9.3]**

Kalman Filter

Recursive Minimum Mean-Square Estimation For Scalar Random Variable, Kalman Filtering Problem, Initial Conditions, Summary of Kalman Filter. [Read Haykin: Chapter 10.1, 10.2, 10.6, 10.7]

Text Books

1. *Bernard Widrow and Samuel D. Stearns, Adaptive Signal Processing, Pearson Education*
2. *Simon Haykin, Adaptive Filter Theory (Fourth Edition), Pearson Education.*

Statistical Signal Processing

Module – 1 **(9 hours)**

Discrete Random Process

Random Process- Ensemble Average, Gaussian Process, Stationary Process, The Autocorrelation and Autocovariance Matrix, Ergodicity, White Noie, The Power Spectrom, Filtering Random Process, Special Types of Random Process-ARMV Process, AR Process, MA Process, Harmonic Process. [Read Hayes Chapter 3.3.1 – 3.3.8, 3.4, 3.6.1 – 3.6.4]

Signal Modeling

Introduction, Stochastic Models- ARMA Models, AR Models, MA Models, Application: Power Spectrum Estimation. [Read Hayes Chapter 4.1, 4.7.1 – 4.7.4]

Module – 2 **(14 hours)**

WINER FILTERING

Introduction, The FIR Wiener Filter- Filtering, Linear Prediction, Noise Cancellation, IIR Wiener Filter- Noncausal IIR Wiener Filter, The Causal IIR Wiener Filter, Causal Wiener Filtering, Causal Linear Prediction, Wiener Deconvolution, Discrete Kalman Filter. [Read Hayes Chapter 7.1, 7.2.1 – 7.2.3, 7.3.1 – 7.3.5, 7.4)

SPECTRUM ESTIMATION

Introduction, Nonparametric Method- The Periodogram, Performance of Periodogram. Parametric Methods- AR Spectrum Estimation, MA Spectrum Estimation, ARMA Spectrum Estimation. Frequency Estimation- Eigendecomposition of the Autocorrelation Matrix, MUSIC. [Read Hayes Chapter 8.1, 8.2.1, 8.2.2, 8.5.1 – 8.5.3, 8.6.1, 8.6.3]

Module – 3 **(11 hours)**

ADAPTIVE FILTERING

Introduction, FIR Adaptive Filters- The Steepest Descent Adaptive Filter, The LMS Algorithm, Convergence of LMS Algorithm, NLMS, Noise Cancellation, LMS Based Adaptive Filter, Channel Equalization, Adaptive Recursive Filter, RLS- Exponentially Weighted RLS, Sliding Window RLS. [Read Hayes Chapter 9.1, 9.2.1 – 9.2.6, 9.2.9, 9.3, 9.4]

Text Book

1. *Monson H. Hayes, Statistical Digital Signal Processing & Modeling, John Wiley & Sons*

Reference Books

1. *Steven M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall.*

Digital and Adaptive Control

MODULE – I **(11 hours)**

Review of Spectrum Analysis and Sampling Process. Reconstructing Original Signals from sampled signals: Sampling theorm, Ideal lowpass filter, frequency responce characteristics of the zero-order Hold, folding, aliasing. Pulse Transfermation: Pulse ternsfer function of closed loop systems, Pulse transfer function of Digital PID controllers.

MODULE – II **(11 hours)**

Transient and steady state response analysis of Digital control system: Deadbeat response, Digital control system with state feedback. State regular, State observer, combined state feedback control and state Estimation, Deedbeat control by state feedback and Dead beat observer. Optimal Digital Control System: Discrete Algebraic Riccati Equation.

MODULE – III **(12 hours)**

Adaptive Control: Introduction to adaptive control. Model Reference Adaptive Control (MARC) sy
Relation between MRAC and STR. Introduction to sliding Mode Control (Variable Structure Control).

Textbooks:

1. K. Ogata, ***Discrete-Time Control System*****,** 2nd edn., Pearson Education, Printed by Thomson Press (India).
2. M. Gopal, ***Digital Control and State Variable Methods*****,** 3rd edn., Tata McGraw-Hill Publishing Company Ltd., New Delhi.
3. Eronini Umez-Eronini, ***System Dynamics and Control***, Thomson Books/Cole Publication.

Fiber Optics and Laser Instrumentation

MODULE – I **(11 hours)**

Optical Fibers and their Properties

Principles of light propagation through a fiber, Different types of fibers and their properties, Transmission characteristics of optical fiber, Absorption losses, Scattering losses, Dispersion, Optical fiber measurement, Optical sources, Optical detectors, LED-LD-PIN and APD.

Industrial Application of Optical Fibers

Fiber optic sensors, Fiber optic instrumentation system, Different types of modulators, Detectors, Application in instrumentation, Interferometric method of measurement of length, Moiré fringes, Measurement of pressure, temperature, current, voltage, liquid level and strain, Fiber optic gyroscope, Polarization maintaining fibers.

MODULE – II **(11 hours)**

Laser Fundamentals

Fundamental characteristics of Lasers, Three level and four level lasers, Properties of laser, Laser modes, Resonator configuration, Q-switching and mode locking, Cavity dumping, Types of lasers: gas lasers, solid lasers, liquid lasers, semi conductor lasers.

Industrial Application of Lasers

Laser for measurement of distance, length velocity, acceleration, current, voltage and atmospheric effect, Material processing, Laser heating, welding, melting and trimming of materials, Removal and vaporization.

MODULE – III **(12 hours)**

Hologram and Medical Application

Holography, Basic principle, methods, Holographic interferometry and applications, Holography for non-destructive testing, Holographic components, Medical applications of lasers, Laser and tissue interaction, Laser instruments for surgery, Application of Laser for removal of tumours, brain surgery, plastic surgery, gynaecology and oncology.

Textbooks:

1. *John and Harry, **Industrial Lasers and their Applications**, McGraw Hill, 1974.*
2. *Senior J.M., **Optical Fiber Communication Principles and Practice**, Prentice Hall, 1985.*

Recommended Reading:

1. *John F Read, **Industrial Applications of Lasers**, Academic Press, 1978*
2. *MonteRoss, **Laser Applications**, McGraw Hill, 1968*
3. *Keiser G., **Optical Fiber Communication**, McGraw Hill, 1991*
4. *Jasprit Singh, **Semiconductor Optoelectronics**, McGraw Hill, 1995*
5. *Ghatak A.K and Thiagarajar K, Optical Electronics Foundation Book, TMH, New Delhi, 1991.*

Control System Design

Module – I (12 Hours)

Introduction: Application of software and simulink for control system design, Review of compensation technique and choice of optimum parameters to obtain desired performance, Absolute stability and relative stability concepts.

Design of Linear Control Systems: Transient and steady state response; Polar, Bode, Root locus plots; Reshaping of these plots to obtain desired response, Initial condition and forced response, A simple lag – lead design.

Module – II (14 Hours)

Design of Control Systems by State Variable Techniques: Controllability, Observability; Stability by using computer methods; solution of state and output equations of closed loop systems. Pole placement design, Observer design. Linear / quadratic optimal control. Full and reduced order observers.

Design of Nonlinear Control Systems: Phase plane technique, Describing Function method for nonlinearities like saturation, dead space, ON/OFF (Ideal Relay type nonlinearity). Simulation techniques.

Module – III (14 Hours)

PID Controller: Use of digital computer as a compensator device, basic computer control scheme, tunable PID controller, Ziegler – Nichol's method, Simulation of multiloop control system using P, PI, PD, PID controller and finding the system response. Standard compensator structures (P, PD, PI and PID control).

Design of Digital Control System: Technique and methodology; Computation of digital equivalent of the analog controller, simulation of performance of the design. Digital controller design, Regulator and observer design; Digital servo for inverted pendulum.

Textbooks:

1. G. C. Goodwin, S. F. Graebe, M. E. Salgado, ***Control System Design***, Prentice Hall of India, 2001.
2. George Ellis, ***Control System Design Guide – A Practical Guide***, 3rd Edition, Academic Press, 2005 Indian Reprint, ISBN: 81-8147-596-8.
3. Norman S. Nise, ***Control Systems Engineering***, 3rd Edition, Wiley.

Recommended Reading:

1. M. Gopal, ***Digital Control and State Variable Method***, Tata McGraw Hill.
2. Hadi Saadat, ***Computational Aids in Control System Using MATLAB***, McGraw Hill International.
3. Ogata K., ***Modern Control Engineering***, 4th Edition, Prentice Hall
4. Ogata K. ***System Dynamics***, 3rd Edition, Prentice Hall
5. M. Gopal, ***Control Systems Principles and Design***, 2nd Edition, Tata McGraw Hill

Modeling and Simulation (3-1-0) Credit : 4

Module – I **(12 Hours)**

Basic Simulation Modeling: The Nature of Simulation, Systems, Models, and Simulation, Discrete-Event Simulation, Simulation of a Single-Server Queueing System, Simulation of an Inventory System, Alternative Approaches to Modeling and Coding Simulations, Steps in a Sound Simulation Study, Other Types of Simulation, Advantages, Disadvantages, and Pitfalls of Simulation.

Modeling Complex Systems: Introduction, List Processing in Simulation, A Simple Simulation Language: simlib, Single-Server Queueing Simulation with simlib, Time-Shared Computer Model, Multiteller Bank with Jockeying, Job-Shop Model, Efficient Event-List Manipulation.

Simulation Software: Introduction, Comparison of Simulation Packages with Programming Languages, Classification of Simulation Software, Desirable Software Features, General-Purpose Simulation Packages, Object-Oriented Simulation, Examples of Application-Oriented Simulation Packages.

Module – II **(14 Hours)**

Review of Basic Probability and Statistics: Introduction, Random Variables and Their Properties, Simulation Output Data and Stochastic Processes, Estimation of Means, Variances, and Correlations, Confidence Intervals and Hypothesis Tests for the Mean, The Strong Law of Large Numbers, The Danger of Replacing a Probability Distribution by its Mean.

Building Valid, Credible, and Appropriately Detailed Simulation Models: Introduction and Definitions, Guidelines for Determining the Level of Model Detail, Verification of Simulation Computer Programs, Techniques for Increasing Model Validity and Credibility, Management's Role in the Simulation Process, Statistical Procedures for Comparing Real-World Observations and Simulation Output Data.

Selecting Input Probability Distributions: Introduction, Useful Probability Distributions, Techniques for Assessing Sample Independence, Activity I: Hypothesizing Families of Distributions, Activity II: Estimation of Parameters, The ExpertFit Software and an Extended Example, Shifted and Truncated Distributions, Bézier Distributions, Specifying Multivariate Distributions, Correlations, and Stochastic Processes, Selecting a Distribution in the Absence of Data, Models of Arrival Processes, Assessing the Homogeneity of Different Data Sets.

Random-Number Generators: Introduction, Linear Congruential Generators, Other Kinds of Generators, Testing Random-Number Generators.

Generating Random Variates: Introduction, General Approaches to Generating Random Variates, Generating Continuous Random Variates, Generating Discrete Random Variates, Generating Random Vectors, Correlated Random Variates, and Stochastic Processes, Generating Arrival Processes.

Module – III (14 Hours)

Output Data Analysis for a Single System: Introduction, Transient and Steady-State Behavior of a Stochastic Process, Types of Simulations with Regard to Output Analysis, Statistical Analysis for Terminating Simulations, Statistical Analysis for Steady-State Parameters, Statistical Analysis for Steady-State Cycle Parameters, Multiple Measures of Performance, Time Plots of Important Variables.

Comparing Alternative System Configurations: Introduction, Confidence Intervals for the Difference Between the Expected Responses of Two Systems, Confidence Intervals for Comparing More than Two Systems, Ranking and Selection.

Variance-Reduction Techniques: Introduction, Common Random Numbers, Antithetic Variates, Control Variates, Indirect Estimation, Conditioning.

Experimental Design, Sensitivity Analysis, and Optimization: Introduction, 2k Factorial Designs, Coping with Many Factors, Response Surfaces and Metamodels, Sensitivity and Gradient Estimation, Optimum Seeking.

Simulation of Manufacturing Systems: Introduction, Objectives of Simulation in Manufacturing, Simulation Software for Manufacturing Applications, Modeling System Randomness, An Extended Example, A Simulation Case Study of a Metal-Parts Manufacturing Facility.

Textbooks:

1. Averill M. Law and W. David Kelton, ***Simulation Modeling and Analysis***, 3rd Edn., McGraw Hill, 2000, ISBN-10: 0070366985, ISBN-13: 978-0070366985.

Recommended Reading:

1. Bernard P. Zeigler, Herbert Praehofer amd Tag Gon Kim, ***Theory of Modeling and Simulation***, 2nd Edn., Academic Press, 2000, ISBN-10: 0127784551, ISBN-13: 978-0127784557.
2. Frank L. Severance, ***System Modeling and Simulation: An Introduction***, Wiley, 2001, ISBN-10: 0471496944, ISBN-13: 978-0471496946.
3. Forbes T. Brown, ***Engineering System Dynamics: A Unified Graph-Centered Approach***, 2nd Edn., CRC Press, 2001, ISBN 10**:** 0849396484, ISBN-13: 978-0849396489.

Virtual Instrumentation

MODULE – I (11 hours)

Introduction to Virtual Instrumentation: Computers in instrumentation, What is Virtual instrumentation (VI), History of VI, LabVIEW and VI, Conventional and graphical programming, Distributed systems.

Basics of LabVIEW: Components of LabVIEW, Owned and free labels, Tools and other palettes, Arranging objects, pop-up menu, Colour coding, Code debugging, Context sensitive help, Creating sub-Vis.

FOR and WHILE Loops: The FOR loop, The WHILE loop, Additional loop problem, Loop behaviour and interloop communication, Local variables, Global variables, Shift registers, Feedback, Autoindexing, Loop timong, Timed loop.

Other Structures: Sequence structures, Case structures, Formula node, Event structure.

Arrays and Clusters: Arrays, Clusters, inter-conversion of arrays and clusters.

MODULE – II (11 hours)

Graphs and Charts: Waveform chart, Resetting plots, Waveform graph, Use of cursors, X-Y graph.

State Machines: What is a state machine? A simple state machine, Event structures, The full state machine, Notes and comments.

File Input/Output: File formats, File I/O functions, Path functions, Sample VIs to demonstrate file WRITE and READ, Generatinf file names automatically.

String Handling: String functions, LabVIEW string formats, Examples, Some more functions, Parsing of strings.

Basics of Data Acquisition: Classification of signals, Read-world signals, Analog interfacing, Connecting the signal to the board, Guidelines, Practical versus ideal interfacing, Bridge signal sources.

MODULE – III (12 hours)

Data Acquisition with LabVIEW DAQmx and DAQ Vis: Measurement and automation explorer, The waveform data type, Working in DAQmx, Working in NI-DAQ (Legacy DAQ), Use of simple VIs, Intermediate VIs.

Interfacing with Assistants: DAQ assistant, Analysis assistant, Instrument assistant.

Interfacing Instruments: GPIB and RS232: RS232C versus GPIB, Handshaking, GPIB interfacing, RS232C/RS485 interfacing, Standard commands for programmable instruments, VISA, Instrument interfacing and LabVIEW.

Advanced Topics in LabVIEW: Interprocess communication, Other related tools (Queue, Semaphore, Rendezvous and Occurrence), Wait for front panel activity, Data sockets, Progrmmatically printing front panels.

Distributed Systems: Basic, Programming in FPGA, Operating in a batch mode, Wave server versus data socket.

Textbooks:

1. Sanjay Gupta and Joseph John, ***Virtual Instrumentation Using LabVIEW***, 2nd Edn., Tata McGraw-Hill, 2010, **ISBN-10:** 0-07-07002**8-1**, **ISBN-13:** 978-0-07-070028-4.

Recommended Reading:

1. Jerome Jovitha, ***Virtual Instrumentation Using Labview***, PHI Learning,, 2010, **ISBN-10:** 8120340302, **ISBN-13:** 9788120340305, 978-8120340305.
2. Gary W. Johnson and Richard Jeninngs, ***LabVIEW Graphical Programming***, 4th Edn., McGrawHill, 2006.
3. J. Travis and J. Kring, ***LabVIEW for Everyone***, 3rd Edn., Prentice Hall, 2006.
4. Peter A. Blume, ***The LabVIEW Style Book***, Prentice Hall, 2007.

Communication Protocols for Instrumentation

MODULE – I (11 hours)

An Introduction to Networks in Process Automation: Information flow requirements, Hierarchical communication model, Data Communication basics, OSI reference model, Industry Network, Recent networks.

Introduction to Communication Protocols: Communication basics, Network Classification, Device Networks, Control Networks, Enterprise Networking, Network selection.

MODULE – II (11 hours)

Proprietary and Open Networks: Network Architectures, Building blocks, Industry open protocols (RS-232C, RS- 422, RS-485), Ethernet, Modbus, Modbus Plus, Data Highway Plus, Advantages and Limitations of Open networks.

Fieldbus: Fieldbus Trends, Hardware selection, Fieldbus design, Installation, Documentation, Fieldbus advantages and limitations.

MODULE – III (12 hours)

HART: Introduction, Design, Installation, calibration, commissioning, Application in Hazardous and Non-Hazardous area.

Foundation Fieldbus & Profibus: Introduction, Design, Calibration, Commissioning, Application in Hazardous and Non-Hazardous area.

Introduction to Wireless Protocols: WPAN, Wi-Fi, Bluetooth, ZigBee, Z-wave.

Textbooks:

1. B.G. Liptak, ***Instrument Engineers' Handbook, Third Edition, Volume Three: Process Software and Digital Networks***, CRC Press ISA – The Instrumentation, Systems, and Automation Society, 2020, **ISBN:** 9780849310829, **ISBN 10:** 0849310822.
2. Steve Mackay, Edwin Wright and John Park, ***Practical Data Communications for Instrumentation and Control (IDC Technology)***, Newnes (Elsevier), 1st Edn, 2003, **ISBN-10:** 0750657979, **ISBN-13:** 978-0750657976.

Recommended Reading:

1. Romilly Bowden, ***HART Field Communications Protocol***, Fisher-Rosemount, 1997.
2. User Manuals of Foundation Fieldbus, Profibus, Modbus, Ethernet, Devicenet, Controlnet

Industrial Telematics

MODULE – I (11 hours)
Ethernet and Wireless Network Technologies: Approaches to Enforce Real-Time Behavior in Ethernet, Switched Ethernet in Automation Networking, Wireless LAN Technology for the Factory Floor: Challenges and Approaches, Wireless Local and Wireless Personal Area Network Technologies for Industrial Development.

MODULE – II (11 hours)
Linking Factory Floor with the Internet and Wireless Fieldbuses: Linking Factory Floor and the Internet, Extending EIA-709 Control Networks across IP Channels, Interconnection of Wireline and Wireless Fieldbuses.
Network Security and Safety Technologies in Industrial Networks: Security Topics and Solutions for Automation Networks, PROFIsafe: Safety Technology with PROFIBUS.

MODULE – III (12 hours)
Applications of Networks and Other Technologies: Automotive Communication Technologies, Design of Automotive X-by-Wire Systems, FlexRay Communication Technology, The LIN Standard, Volcano: Enabling Correctness by Design, Networks In Building Automation, The Use of Network Hierarchies in Building Telemetry and Control Applications, EIB: European Installation Bus, Fundamentals of LonWorks/EIA-709 Networks: ANSI/EIA-709 Protocol Standard (LonTalk), Manufacturing Message Specification In Industrial Automation, The Standard Message Specification for Industrial Automation Systems: ISO 9506 (MMS), Virtual Factory Communication System Using ISO 9506 and Its Application to Networked Factory Machine, Motion Control, The SERCOS interface™, Train Communication Network, The IEC/IEEE Train Communication Network, Smart Transducer Interface, A Smart Transducer Interface Standard for Sensors and Actuators, Energy Systems, Applying IEC 61375 (Train Communication Network) to Data Communication in Electrical Substations, SEMI, SEMI Interface and Communication Standards: An Overview and Case Study.

Textbooks:

1. Richard Zurawski, ***The Industrial Communication Technology Handbook (Industrial Information Technology)***, Taylor and Francis, (CRC Press), ISA – The Instrumentation, Systems, and Automation Society, 2005, ISBN-10: 0849330777, ISBN-13: 978-0849330773.

Recommended Reading:

1. Richard Zurawski, ***Integration Technologies for Industrial Automated Systems (Industrial Information Technology)***, Taylor and Francis, (CRC Press), ISA – The Instrumentation, Systems, and Automation Society, 2006, ISBN-10: 0849392624, ISBN-13: 978-0849392627.
2. Richard Zurawski, ***The Industrial Information Technology Handbook (Industrial Electronics)***, Taylor and Francis, (CRC Press), ISA – The Instrumentation, Systems, and Automation Society, 2004, ISBN-10: 0849319854, ISBN-13: 978-0849319853

Nonlinear Systems

MODULE – I (11 hours)

Introduction to Non Linear System: Classification of non-linearity, types of non-linearity in physical system, jump phenomena and critical jump resonance curve, methods of analysis of non-linear systems and comparison, linearization, slope, isoclines, singular point, limit cycle.

Phase Plane Analysis: Concept of phase plane, phase trajectory, phase portraits, methods of plotting phase plane trajectories Vander Pol's equation, stability from phase portrait, time response from trajectories, isoclines method, Pell's method of phase trajectory, Delta method of phase trajectory construction.

MODULE – II (11 hours)

Frequency Domain Analysis: Absolute stability, circle criterion, Popov criterion Describing function, DF of typical nonlinearities stability analysis using DF method, DIDF, pole zero shifting transformation.

Liapunov Stability: Autonomous Systems: Stability of equilibrium point. Concepts of positive definite/semi definite, negative definite/ semi definite, indefinite functions, Lyapunov function Liapunov Stability: asymptotic stability, global asymptotic stability.

MODULE – III (12 hours)

Stability Criterion: Linear systems, linearization of nonlinear systems about equilibrium point. Liapunov's indirect method. Stability analysis of nonlinear system using Liapunov's theorem.

Nonlinear Control Design: Feedback linearization, Input Output linearization, sliding mode control.

Textbooks:

1. Hasan A. Khalil, ***Nonlinear Systems***, Printece Hall of India.
2. George J. Thaler Brown, ***Automatic Control System***, Jaico Publications.

Recommended Reading:

1. Samarjit Ghosh, ***Control Systems Theory and Application***, Pearson Education.
2. Nagrath and Gopal, ***Control System Engineering***, Wiley Eastern.
3. A. K. Mandal, ***Introduction to Control Engineering***, New Age International Publications.

<u>Real Time Instrumentation (3 – 0 – 0) Credits: 3</u>

MODULE – I **(10 hours)**

INTRODUCTION: Typical Real-Time applications – Digital control, High-level controls, Signal processing, Other real-time applications, Hard versus soft real-time systems – Jobs and processors, Release time, Deadlines, and Timing constraints, Hard real-time systems, Soft real-time systems, A reference model of real-time systems – Processors and Resources, Temporal parameters of real-time workload, Periodic task model, Precedence constraints and Data dependency, Other types of dependencies, Functional parameters, Resource parameters of job and Parameters of resources, Scheduling hierarchy.

MODULE – II **(12 hours)**

CLASSIC UNIPROCESSOR SCHEDULING RESULTS: Commonly used approaches to real-time scheduling with emphasis on optimality of EDF and LST algorithms, Clock-driven scheduling with emphasis on Cyclic executive, Priority-driven scheduling of periodic tasks – Maximum scheduling utilisation, Optimality of RM and DM algorithms, A schedulability test for fixed-priority tasks with short response times, Schedulability test for fixed-priority tasks with arbitrary response times, Sufficient schedulabilty conditions for the RM and DM algorithms, Some real systems – Overview, Time services and scheduling mechanisms, Capabilities of commercial real-time operating systems, Predictability of General-purpose operating systems.

MODULE – III **(12 hours)**

BEYOND UNIPROCESSOR INDEPENDENT TASK MODELS: Scheduling aperiodic and sporadic jobs in priority-driven systems – Assumptions and approaches, Deferrable servers, Sporadic servers, Constant utilisation, Total bandwidth and Weighted fair-queuing servers, Resources and resource access control – Assumptions on resources and their uses, Effect of resource contention and resource access control, Nonpreemptive critical sections, Basic priority-inheritance protocol, Basic priority-ceiling protocol, Stack-based, Priority-ceiling (Ceiling-priority) protocol, Multiprocessor scheduling, Resource access control and synchronisation – Model of multiprocessor and distributed system, Task assignment, Multiprocessor priority ceiling protocol, Elements of scheduling algorithms for end-to-end tasks.

Textbooks:

1. Jane W.S. Liu, ***Real-Time Systems*,** Pearson Education, 2000, ISBN: 978-81-7758-575-9.

Recommended Reading:

1. C.M. Krishna and K.G. Shin, ***Real-Time Systems*,** McGraw Hill, 1997, ISBN 0-07-057043-4.
2. Rajib Mall, ***Real-Time Systems – Theory and Practice*,** Pearson Education, 2007, ISBN: 978-81-317-0069-3.
3. Philip. A. Laplante, ***Real-Time Systems Design and Analysis - an Engineer's Handbook, 3rd Edition*,** John Wiley & Sons, Incorporated, ISBN: 0-471-22855-9.
4. Dr. K.V.K K Prasad, ***Embedded Real Time Systems: Concepts Design and Programming*,** Dreamtech Press New Delhi, 2003.

PC Based Instrumentation

MODULE – I (11 hours)

INTRODUCTION: Review of microprocessors, microcomputers, micro processing systems - Input-output structures - Measurement of digital computer power and performance.

INTERFACING: Analogue signal conversion – Interface components and techniques - Signal processing - Interface systems and standards – Communications.

MODULE – II (11 hours)

SOFTWARE: Real time languages – Programming real time systems - Discrete PID algorithms -Real time operating systems - Case studies in instrumentation.

MODULE – III (12 hours)

APPLICATION EXAMPLES IN MEASUREMENT AND CONTROL: PC based data - Acquisition systems - Industrial process measurements, like flow temperature, pressure, and level PC based instruments development system.

Textbooks:

2. Ahson, S.I., “Microprocessors with applications in process control”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1984.
3. George Barney C., “Intelligent Instrumentation”, Prentice Hall of India Pvt. Ltd., New Delhi, 1998.
4. Krishna Kant, “Computer based industrial control”, Prentice Hall, 1997.

Recommended Reading:

4. .
5. .

Biomedical Instrumentation and Signal Processing (3 – 0 – 0) Credits: 3

MODULE – I **(10 hours)**

Introduction: Cell structure, basic cell function, origin of bio-potentials, electric activity of cells.

Biotransducers: Physiological parameters and suitable transducers for its measurements, operating principles and specifications for the transducers to measure parameters like blood flow, blood pressure, electrode sensor, temperature, displacement transducers.

MODULE – II **(12 hours)**

Cardiovascular system: Heart structure, cardiac cycle, **ECG** (electrocardiogram) theory (B.D.), **PCG** (phonocardiogram). **EEG, X-Ray, Sonography, CT-Scan**,The nature of biomedical signals.

Analog signal processing of Biosignals: Amplifiers, Transient Protection, Interference Reduction, Movement Artifact Circuits, Active filters, Rate Measurement. Averaging and Integrator Circuits, Transient Protection circuits.

MODULE – III **(13 hours)**

Time-frequency representations: Introduction, Short-time Fourier transform, spectrogram, wavelet signal decomposition.

Biomedical applications: Fourier, Laplace and z-transforms, autocorrelation, crosscorrelation, power spectral density.

Noise: Different sources of noise, Noise removal and signal compensation.

Software based medical signal detection and pattern recognition.

TextBooks:

1. R S Kandpur, ***Handbook of Biomedical Instrumentation***, 2nd Edn, TMH Publication, 2003
2. E. N. Bruce, ***Biomedical Signal Processing and Signal Modelling***, John Wiley, 2001.

References

1. Wills J. Tompkins, ***Biomedical Digital Signal Processing***, PHI.
2. M. Akay, ***Time Frequency and Wavelets in Biomedical Signal Processing***, IEEE Press, 1998.
3. Cromwell, ***Biomedical Instrumentation and Measurements***, 2nd Edn, Pearson Education.

Embedded System Design

MODULE – I (11 hours)

Introduction to Embedded Computing: Terms and scope, Application areas, Growing importance of embedded systems.

Specifications: Requirements, Models of computation, State Charts: Modeling of hierarchy, Timers, Edge labels and StateCharts semantics, Evaluation and extensions, General language characteristics: Synchronous and asynchronous languages, Process concepts, Synchronization and communication, Specifying timing, Using non-standard I/O devices, SDL, Petri nets: Introduction, Condition/event nets, Place/transition nets, Predicate/transition nets, Evaluation, Message Sequence Charts, UML, Process networks: Task graphs, Asynchronous message passing, Synchronous message passing, Java, VHDL: Introduction, Entities and architectures, Multi-valued logic and IEEE 1164, VHDL processes and simulation semantics, System C, Verilog and System Verilog, Spec C, Additional languages, Levels of hardware modelling, Language comparison, Dependability requirements.

MODULE – II (11 hours)

Embedded System Hardware: Introduction, Input: Sensors, Sample-and-hold circuits, A/D-converters, Communication: Requirements, Electrical robustness, Guaranteeing real-time behaviour, Examples, Processing units: Application-Specific Circuits (ASICs), Processors, Reconfigurable Logic, Memories, Output: D/A-converters, Actuators.

Standard Software: Embedded Operating Systems, Middleware, and Scheduling: Prediction of execution times, Scheduling in real-time systems: Classification of scheduling algorithms, Aperiodic scheduling, Periodic scheduling, Resource access protocols, Embedded operating systems: General requirements, Real-time operating systems, Middleware: Real-time data bases, Access to remote objects

MODULE – III (12 hours)

Implementing Embedded Systems: Hardware/Software Co-design: Task level concurrency management, High-level optimizations: Floating-point to fixed-point conversion, Simple loop transformations, Loop tiling/blocking, Loop splitting, Array folding, Hardware/software partitioning: Introduction, COOL, Compilers for embedded systems: Introduction, Energy-aware compilation, Compilation for digital signal processors, Compilation for multimedia processors, Compilation for VLIW processors, Compilation for network processors Compiler generation, retargetable compilers and design space exploration, Voltage Scaling and Power Management: Dynamic Voltage Scaling, Dynamic power management (DPM), Actual design flows and tools: SpecC methodology, IMEC tool flow, The COSYMA design flow, Ptolemy II, he OCTOPUS design flow.

Validation: Introduction, Simulation, Rapid prototyping and emulation, Test: Scope, Design for testability and Self-test programs, Fault simulation, Fault injection, Risk- and dependability analysis, Formal verification.

Textbooks:

4. Peter Marwedel, ***Embedded System Design***, Springer, 2006 http://ls12-www.cs.uni-dortmund.de/~marwedel/kluwer-es-book/

Recommended Reading:

6. Wayne Wolf, ***Computers as Components***, Morgan Kaufmann, 2001 http://www.ee.princeton.edu/~wolf/embedded-book

7. G. De Micheli, Rolf Ernst and Wayne Wolf, eds, ***Readings in Hardware/Software Co-Design***, Morgan Kaufmann, ***Systems-on-Silicon Series Embedded***
8. Frank Vahid and Tony D. Givargis, ***System Design: A Unified Hardware/Software Introduction***, Addison Wesley, 2002.
9. Michael Barr, ***Programming Embedded Systems in C and C++***, O'Reilly, 1999.
10. David E. Simon, ***An Embedded Software Primer***, Addison Wesley, 1999.
11. Jack Ganssle, The Art of Designing Embedded Systems, Newnes, 2000.
12. K. Short, ***Embedded Microprocessor System Design***, Prentice Hall, 1998.

C. Baron, J. Geffroy and G. Motet, ***Embedded System Applications***, Kluwer, 1997.

Microsystems – Principles, Design and Application

MODULE – I (11 hours)

Introduction: MEMS, MEMS Processing, Micromachining, Wafer Bonding, LIGA, MEMS Examples, Scaling Laws

MEMS Materials: MEMS Materials, Silicon, Crystal Defects, Mechanical Properties of Materials, Beams and structures, Piezoelectric Materials, Piezoresistive Materials

MEMS Sensor: Resistive and Capacitive methods, Strain gauges, Piezoresistivity, MEMS Capacitive Sensors, MEMS Position sensor, MEMS Pressure sensor

MODULE – II (11 hours)

MEMS Sensor (Continued): MEMS Accelerometer, MEMS Gyroscope, MEMS Gas Sensors, Cantilever Sensors

MEMS Actuator: Electrostatic MEMS actuators, Comb drives, MEMS RF resonator, Scratch drive, Inchworm motor, Piezoelectric MEMS actuators, Thermal MEMS actuators, Magnetic MEMS actuators

MODULE – III (12 hours)

Optical MEMS: MEMS Infrared sensor, Digital Mirror Displays, Grating Light Valve Displays, Micro-optical elements

Micro-fluidics, Chemical MEMS: Microfluidics – Fluid flow, Electro-osmotic flow, Electrophoresis, Micropumps, Microvalves, Fabrication Process for microfuidic chip, Lab-on-a-Chip, μ-TAS, Inkjet Printer Head

Bio MEMS: DNA Analysis, Micro-array Gene Chip, Micro-surgery, Drug delivery

<u>Text Books</u>:

1. Stephen D. Senturia, ***Microsystem Design***, Kluwer Academic/Springer, 2nd edn. (2005), ISBN: 0792372468
2. R.S. Muller and A.P. Pisano, ***Micro Actuators***, IEEE Press, 2000.
3. P. Rai-Choudhury, ***Recent Advances in MEMS/MOEMS Technologies***, SPIE Press, 2000.
4. S.M. Sze, ***Semiconductor Sensors***, Wiley-Interscience Publishers, 1994.
5. T. Fukuda, and W. Menz, (Eds), ***Micro Mechanical Systems: Principles and Technology, Handbook of Sensors and Actuators***, Vol. 6, Elsevier, 1998.

Reliability Engineering

MODULE – I (11 hours)

Review of basic concepts in Reliability Engg., Reliability function, different reliability models, etc., Reliability evaluation techniques for complex system; Non path set and cutest approaches, path set and cut set approaches, different reliability measures, Reliability allocation/apportionment, reliability improvement, redundancy optimization techniques.

MODULE – II (11 hours)

Fault tree analysis: fault tree construction, simplification and evaluation, importance measures, modularization, applications, advantages and disadvantages of fault tree techniques.

MODULE – III (12 hours)

Maintainability Analysis: measures of system performance, types of maintenance, reliability centered maintenance , reliability and availability evaluation of engineering systems using Markov models.

Applications of fuzzy theory and neural networks to Reliability Engineering. Reliability testing, design for reliability and maintainability. Typical reliability case studies.

Textbooks:

1. R. Ramakumar, ***Engineering Reliability***, Prentice Hall, NJ.
2. M.L. Shooman, ***Probabilistic Reliability – An Engineering Approach***, RE Krieger Pub., 1990.

Recommended Reading:

1. KB Mishra, ***Reliability Analysis and Prediction***,
2. KB Mishra, ***New Trends in System Reliability Evaluation***,
3. K.K. Aggarwal, ***Reliability Engineering***,

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