KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous Institution affiliated to Anna University of Technology, Coimbatore)

M.E. DEGREE IN CONTROL AND INSTRUMENTATION ENGINEERING (FULL TIME)

CURRICULUM

(For the candidates admitted from academic year 2011 – 12 onwards)

SEMESTER-I

Course code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
11CI101	Applied Mathematics for Control Engineers	3	1	0	4	50	50	100
11CI102	System theory	3	1	0	4	50	50	100
11CI103	Transducers and Smart Instruments	3	0	0	3	50	50	100
11CI104	Process Dynamics and Control	3	0	0	3	50	50	100
11AE102	Advanced Digital Signal Processing	3	1	0	4	50	50	100
11AE106	Computational Intelligent Techniques	3	1	0	4	50	50	100
	PRACTICAL							
11CI105	Modeling and Simulation Laboratory	0	0	3	1	100	0	100

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CURRICULUM

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SEMESTER-II

Course code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
11CI201	System Identification	3	0	0	3	50	50	100
11CI202	Advanced Process Control	3	0	0	3	50	50	100
11CI203	Industrial Data Networks	3	1	0	4	50	50	100
	Elective - I	3	0	0	3	50	50	100
	Elective - II	3	0	0	3	50	50	100
	Elective - III	3	0	0	3	50	50	100
	PRACTICAL							
11CI204	Industrial Automation Laboratory	0	0	3	1	100	0	100
11CI205	Advanced Process Control Laboratory	0	0	3	1	100	0	100
				Total	**21**			

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M.E. DEGREE IN CONTROL AND INSTRUMENTATION ENGINEERING
(FULL TIME)

CURRICULUM

(For the candidates admitted from academic year 2011 – 12 onwards)

SEMESTER-III

Course code	Course Title	Hours/ Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
	Elective- IV	3	0	0	3	50	50	100
	Elective-V	3	0	0	3	50	50	100
	Elective-VI	3	0	0	3	50	50	100
	PRACTICAL							
11CI301	Project (Phase – I)	0	0	12	6	50	50	100
				Total	**15**			

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	PRACTICAL							
11CI401	Project Work (Phase – II)	0	0	24	12	100	100	200
				Total	**12**			

LIST OF ELECTIVES					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
11AE016	Electronic Product Design	3	0	0	3
11AE017	Industrial Electronics	3	0	0	3
11AE018	Industrial Robotics	3	0	0	3
11AE020	Microsensors and MEMS	3	0	0	3
11AE103	Advanced Digital System Design	3	1	0	4
11CI011	Advanced Instrumentation System Design	3	1	0	4
11CI012	Applied Industrial Instrumentation	3	0	0	3
11CI013	Microcontroller based System Design	3	0	0	3
11CI014	Robust Control	3	0	0	3
11CI015	Optimal Control Theory	3	1	0	4
11CI016	Adaptive Control Theory	3	1	0	4
11CI017	Biomedical Signal Processing	3	0	0	3
11CI018	Electromagnetic Interference and Compatibility	3	0	0	3
11CI019	State and parameter Estimation	3	0	0	3
11CI020	Drives and Control	3	0	0	3
11CI021	Advanced Digital Image Processing	3	0	0	3
11CI022	Real Time Embedded Systems	3	0	0	3
11CI023	Fault Detection and Diagnosis	3	0	0	3
11CI024	Multi Sensor Data Fusion	3	0	0	3
11VL104	VLSI Signal Processing	3	1	0	4

11CI101 APPLIED MATHEMATICS FOR CONTROL ENGINEERS

3 1 0 4

Objective:

On completion of the course the students are expected

- To understand the concept of variational problems and to find out the extremals of the given functional
- To know about the special types of non-linear ordinary differential equations.
- To solve partial differential equations with the use of finite difference approximations.

MODULE – I **15**

Calculus of Variation: Functional –definition-Variational problem: Euler Lagrange equation-Solutions of Euler Lagrange equation – Variational problems involving one unknown function, Several unknown functions – Functionals dependent on higher order derivatives – Variational problems involving Several independent variables .Isoperimetric problems-Ritz method.

Introduction to Optimization: Linear Programming Problem: Mathematical Formulation – Basic definitions – Solutions of LPP: Graphical method, Simplex method –Big–M method and Two phase method.

MODULE– II **15**

Matrix Theory: Special vectors and Matrices, Matrix inversion lemma - Least square normal equations - The Cholesky decomposition – Toeplitz matrices and their solutions – Singular value decomposition.

Non-Linear Ordinary Differential Equations: Introduction – Equations with separable variables – Equations reduced to linear form – Bernoulli's equation – Riccati's equation – Special form of Riccati's equation – Non-linear pendulum – Duffing's equations.

MODULE–III **15**

Partial Differential Equations: Solving boundary value problems by finite difference method –Finite difference solution for one dimensional heat equation by Implicit and Explicit methods – One dimensional wave equation – Two dimensional Laplace and Poisson equations.

Lecture : 45, Tutorial : 15, TOTAL : 60

REFERENCE BOOKS

1. Venkataraman. M.K, "Higher Mathematics for Engineering & Science", National Publishing Company, 2006.
2. Taha, H.A., "Operations Research- An Introduction", 6th Edition, PHI, 2000.
3. Trembly J.P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw–Hill, New Delhi, 2008.
4. Ale Bjord, " Numerical Methods for least square problems, society for industrial and applied Mathematics,Philadelphia.pa, SIAM 1996
5. Kanti Swarup Gupta, P.K and Man Mohan "Operations Research", S.Chand & Co ., 1997.

11CI102 SYSTEM THEORY

(Common to M.E. Control and Instrumentation, Power Electronics **)**

3 1 0 4

Objective:

On completion of the course the students are expected

- To understand the concept of State space approach and Dynamic Programming.
- To enhance the knowledge about State feedback and Non-linear Systems.
- To know about Describing Function Techniques and Stability analysis**.**

MODULE - I **15**

State Variable Analysis: Review of state variable representation and state variable models in continuous systems. Solutions of state equations- State transition matrix and its properties — free and forced responses -State description of sampled continuous time plants and systems with dead time. Solutions of difference equations-Relation between transfer function and state variable representation. Controllability and observability-Effect of sampling on controllability and observability.

MODULE - II **15**

State feedback: - Effects of state feedback, pole placement and feedback gain matrix- State estimators: Full-dimensional state estimator – reduced dimensional state estimator - connection of state feedback and state estimator – PI feedback- Deadbeat Observers- Dead beat Control.

Non-linear Systems:- Behaviour of non-linear systems, jump resonance, sub-harmonic oscillation- Phase plane analysis: Singular points - construction of phase portraits using isoclines- limit cycle analysis

MODULE - III **15**

Describing Function Techniques: Describing Function of nonlinearities - gain function and its determination for analytically and graphically defined nonlinearities- conditions for stability - stability of oscillation - accuracy of Describing Function method - stability of systems with multiple nonlinearities - closed-loop frequency response

Stability analysis: Stability in the sense of Liapunov - second method of Liapunov - Liapunov stability analysis of linear time invariant systems and non linear system- Krasovski's theorem- variable gradient method of generating Liapunov functions.

Lecture: 45, Tutorial :15 TOTAL: 60

REFERENCE BOOKS

1. Gopal, M., "Digital Control and State Variable Methods", Tata McGraw-Hill, New Delhi, 2008.
2. Katsuhiko Ogata, Modern Control Engineering, Prentice Hall of India Pvt. Ltd., 4th Edition 2002.
3. Houpis, C.H, Digital Control System- Theory, Hardware and Software, Second Edition, McGraw-Hill, New York 1999
4. Gibson, J.E, Nonlinear Automatic Control, McGraw Hill Book Co, 1963.
5. Cunningham, W.J., Introduction to Nonlinear Analysis McGraw Hill, 1958
6. Chen. C.T., Linear System Theory and Design, Holt Rinebart and Winston, 1984
7. Kuo, B.C., "Digital Control Systems", Oxford University Press, Oxford, 2003.

11CI103 TRANSDUCERS AND SMART INSTRUMENTS

3 0 0 3

Objectives:

On completion of the course the students are expected

- To understand the concept of Measurement Science and transducers
- To enhance the knowledge about measurements of spatial variables, optical variables, chemical variables and also about smart sensors
- To know about micro sensors and actuator and also about film sensors.

MODULE - I **15**

Review of measurement science: Types of errors – Limiting error – probable error – propagation of error – odds and uncertainty. Static characteristics: Linearity, Sensitivity, Precision and Resolution, Threshold and Hysteresis. Dynamic characteristics: Impulse, Step and Ramp responses of First order and Second order Transducers.

Review of Transducers: RTD, Strain gauges – Linear Variable Differential Transformer –Capacitive transducers – Piezo electric transducers – Digital Transducers

MODULE - II **15**

Spatial variable measurement: Laser Interferometer Displacement sensor-synchro /Resolver displacement transducer.

Optical variables measurement: Vision and image sensors.

Chemical variables measurement: Thermal composition measurement – Kinetic methods.

Environmental measurement: Meteorological measurement – Air pollution measurement – Water quality measurement – Satellite imaging and sensing.

Smart Sensors: Primary and Secondary sensors – Amplification – Filters – Converters – Compensation – Information coding / processing – Data communication, standards for smart sensor interface – Smart transmitter with HART communicator – Smart sensor for flow and temperature measurement.

MODULE - III **15**

Micro Sensors & Actuators: Micro system design and fabrication – Micro pressure sensors (piezo resistive and capacitive) – Resonant sensors – Acoustic wave sensors – Bio micro sensors – Micro actuators – Micro mechanical motors and pumps.

Film sensors : Thick film and thin film – Integrated image sensors – Bio sensors – Integrated micro arrays – RFIDs – Sensor arrays – Sensor network – Multi-sensor data fusion – Soft sensor.

Lecture: 45, TOTAL: 45

REFERENCE BOOKS

1. John G Webster , Measurement , Instrumentation and Sensors Handbook , CRC press IEEE press, 1998
2. Doebelin, E. A., “Measurement Systems: Applications and Design”, Tata McGraw-Hill, New Delhi, 2003
3. Bela G Liptak , Instruments Engineers’ Handbook Process Measurement and Analysis , Elsevier 2005
4. Patranabis D, Sensors and Transducers, PHI, 2006
5. Tai Ran Hsu , Mems and micro systems design & manufacture , Tata McGraw Hill , 2002

11CI104 PROCESS DYNAMICS AND CONTROL

3 0 0 3

Objectives:

- To introduce about fundamentals of process dynamics and basic control actions
- To enhance the knowledge on controller tuning methods and advanced control techniques
- To introduce the digital control techniques
- To impart the knowledge on Piping and Instrumentation

MODULE - I **15**

Process Dynamics

Introduction to process control-objective of modelling-models of industrial process hydraulic Tanks: Non-interacting system and Interacting system -fluid flow systems-mixing process-chemical reactions-thermal systems: CSTR, heat exchangers and distillation column.

Control Actions

Characteristic of ON-OFF, P, P+I, P+D and P+I+D control modes – Electronic PID controller – Auto/manual transfer - Reset windup. Self Regulatory System. Inverse Response

MODULE - II **15**

Controller Tuning

Evaluation criteria – IAE, ISE, ITAE and ¼ decay ratio. Controller tuning: Process Reaction Curve method, Z-N method, ¼ decay ratio method -time response and frequency response methods- non-linear controllers.

Control Valves

Performance-Types of control valves- Need of Valve Positioner – Characteristic of Control Valves: Inherent and Installed characteristics – Valve sizing

MODULE - III **15**

Enhancement to Single Loop Regulatory Control

Feedback and Feed forward control –ratio control –cascade control -split range control –inferential control –override control.

Model Based Control Schemes

Dead-time compensation: Smith predictor control scheme- Internal Model Controller- Single variable Model predictive control – Single Loop DMC

Introduction to Plant-wide Control and Batch Control - P&ID diagram

TOTAL: 45

REFERENCE BOOKS

1. Stephanopoulos, G, “Chemical Process Control”, Prentice Hall of India, New Delhi, 1990.
2. Bequette, B.W., “Process Control Modeling, Design and Simulation”, Prentice Hall of India, 2004
3. Krishnaswamy K., “Process Control”, New Age International Publishers, New Delhi, 2006.
4. Harriot P., “Process Control”, Tata McGraw-Hill, New Delhi, 1991
5. Norman A Anderson,” Instrumentation for Process Measurement and Control” CRC Press LLC, Florida, 1998
6. Dale E. Seborg, Thomas F Edgar, Duncan A Mellichamp, “Process dynamics and control”, Wiley John and Sons, 1989

11AE102 ADVANCED DIGITAL SIGNAL PROCESSING

(Common to M.E. Applied Electronics, Communication Systems, Power Electronics, Control and Instrumentation, Computer and Communication)

3 1 0 4

Objective:

- To introduce the concept of discrete random signal processing.
- To understand the spectrum estimation and analysis using parametric and non-parametric approach.
- To estimate the signal by linear prediction.
- To study the concepts of adaptive filter and various error minimization algorithm.
- To understand the concepts of multirate digital signal processing.

MODULE – I **15**

Discrete Random Signal Processing: Discrete time random process – Random process: Ensemble averages- Gaussian process – stationary process – The autocovariance and autocorrelation metrices – ergodicity – white noise the power spectrum. Filtering random process – spectral factorization. Parseval's theorem – Wiener Khintchine relation.

Spectrum Estimation and Analysis: Non parmetric methods: Periodogram, performance of periodogram, modified periodogram, Bartlett's method, Welch's method.

MODULE - II **15**

Parametric methods: AR model – Yule-Walker method, MA model – ARMA model.

Linear Prediction: Forward and backward linear predictions, Solution of the normal equations – Levinson-Durbin algorithms. Least mean squared error criterion – The FIR Wiener filter – filtering – linear prediction and The IIR Wiener filters – Non causal IIR Wiener filter – the causal IIR Wiener filter.

Adaptive Filter: Concepts of adaptive filter – FIR adaptive filters – LMS algorithm – Applications: Noise cancellation

MODULE -III **15**

Adaptive Filter: Adaptive recursive filers– AR lattice structure and ARMA process, lattice – ladder filters.

Multirate Digital Signal Processing: Mathematical description of sampling rate – Interpolation and Decimation by integer factor – Sampling rate conversion by rational factor- Filter design for sampling rate conversion; direct form FIR structures, Polyphase structures, time-varient structures. Multistage implementation of sampling rate conversion. Applications – Subband coding of speech signals.

Lecture : 45, Tutorial : 15, TOTAL : 60

REFERENCE BOOKS

1. Hayes, Monson H. "Statistical Digital Signal processing and Modeling", John Wiley and Sons, Inc., 1996.
2. Proakis, John G. and Manolakis, Dimitris G. "Digital Signal Processing: Principles Algorithms and Applications", PHI, 2006.
3 Ifeachor, Emmanuel C. and Jervis, Barrie N. "Digital Signal Processing: A Practical Approach", Addison-Wesley Publishing Company, 2002.
4 George Box, Gwilym M. Jenkins, Gregory Reinsel, "Time Series Analysis: Forecasting & Control", 3rd Edition,

11AE106 COMPUTATIONAL INTELLIGENT TECHNIQUES

(Common to, Applied Electronics, Power Electronics and Control and Instrumentation Engineering and Mechatronics Engineering)

3 1 0 4

Objective:

- To expose the students about the different types of architecture, learning and training methods of neural networks
- To study the concept of rule based system and its modeling
- To expose the students the various optimization techniques
- To learn and analyze the modeling of neuro fuzzy systems
- To study the various real time applications of neuro fuzzy system

MODULE – I **15**

Neural Networks: Introduction to Soft computing – Neural Networks – Supervised learning-Perceptrons – Adaline – Back propagation Multilayer perceptrons – Radial Basis Function Networks – Unsupervised Learning and Other Neural Networks – Competitive Learning Networks – Kohonen Self Organizing Networks – Learning Vector Quantization – Hebbian Learning.

Fuzzy Logic: Fuzzy Sets – Basic Definition and Terminology – Set theoretic operations – Member function formulation and parameterization – Fuzzy Rules and Fuzzy Reasoning

MODULE - II **15**

Fuzzy Logic: Extension principle and Fuzzy Relations – Fuzzy If-Then Rules – Fuzzy Reasoning – Fuzzy Inference Systems – Mamdani Fuzzy Models – Sugeno Fuzzy Models – Tsukamoto Fuzzy Models – Input Space Partitioning and Fuzzy Modeling.

Optimization techniques: Derivative-based Optimization: Descent Methods – The Method of steepest Descent – Classical Newton's Method – Step Size Determination – Derivative free Optimization: Genetic Algorithms – Simulated Annealing – Random Search – Downhill Simplex Search.

MODULE -III **15**

Neuro Fuzzy Modelling: Adaptive Neuro Fuzzy Inference Systems – Architecture – Hybrid Learning Algorithm – learning Methods that Cross-fertilize ANFIS and RBFN – Coactive Neuro Fuzzy Modeling – Framework – Neuron Functions for Adaptive Networks – Neuro Fuzzy Spectrum.

Applications: Printed Character Recognition – Inverse Kinematics Problem – Automobile fuel efficiency prediction – Soft Computing for Color Recipe Prediction – Single MLP approaches – CANFIS modeling for color recipe prediction

Lecture : 45, Tutorial : 15, TOTAL : 60

REFERENCE BOOKS

1. J.S.R Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, Pearson Education, 2004.
2. R.C.Eberhart, P.K.Simpson and R.Dobbins, "Computational Intelligence PC Tools", AP Professional, Boston 1996.
3. David E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, New York, 1989.
4. S.Rajasekaran and G.A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India, New Delhi, 2004.

11CI105 MODELING AND SIMULATION LABORATORY

0 0 3 1

LIST OF EXPERIMENTS

MATLAB

1. Implementation of Image Processing Algorithm using MATLAB
2. Simulation of Adaptive and Non adaptive control systems using MATLAB
3. Implementation of Neural networks Algorithms using MATLAB
4. Implementation of Genetic Algorithm using MATLAB

PSPICE

5. Design of PID Controller using OP-Amp
6. Design of Signal Conditioning Circuit
7. Design of Filters
8. Design of PCB layout

LABVIEW

9. Simulation of ON-OFF controller and tuning of PID controller
10. Simulation of frequency response analysis for I, II and III order systems
11. Interfacing of real time signals using DAQ Card
12. Process parameter control using LabVIEW through LAN network

11CI201 SYSTEM IDENTIFICATION

3 0 0 3

Objectives:

- To introduce the basics about Parameter Estimation Methods.
- To enhance the knowledge about Recursive Identification Methods
- To provide the knowledge about Closed- loop Identification
- To enhance the knowledge about Practical Aspects of Identification

MODULE - I **15**

Introduction

Dynamic systems, Models for Linear Time-invariant Systems, time varying systems and nonlinear systems, The system identification procedure, Non-parametric methods- Transient analysis, Frequency analysis, correlation analysis and spectral analysis.

Parameter Estimation Methods

Least square estimation – best linear unbiased estimation under linear constraints – updating the parameter estimates for linear regression models – prediction error methods: description of prediction methods – optimal prediction – relation between prediction error methods and other identification methods – theoretical analysis - Instrumental variable methods: Description of instrumental variable methods – Input signal design for identification

MODULE - II **15**

Recursive Identification Methods

The recursive least square method – the recursive instrumental variable methods- the recursive prediction error methods – Maximum likelihood.

Closed- loop Identification

Identification of systems operating in closed loop: Identifiability considerations – direct identification – indirect identification – joint input / output identification - Subspace methods for estimating state space models.

MODULE- III **15**

Practical Aspects of Identification

Practical aspects: experimental conditions – drifts and de-trending – outliers and missing data – pre-filtering -robustness – Model validation and Model structure determination-case studies – Introduction to Nonlinear System Identification- Introduction to Control relevant System Identification.

TOTAL: 45

REFERENCE BOOKS

1. Soderstorm T and Peter Stoica, System Identification, Prentice Hall International, 1989
2. Ljung L, System Identification: Theory for the user, Prentice Hall, Englewood Cliffs, 1987.
3. E. Ikonen and K. Najim, " Advanced Process Identification and Control", Marcel Dekker, Inc. New York, 2002.

11CI202 ADVANCED PROCESS CONTROL

3 0 0 3

Objectives:

- To introduce the basics about Multivariable Systems and Multi-Loop Regulatory Control.
- To enhance the knowledge about Multivariable Regulatory Control and Control of Time-Varying and Nonlinear Systems,
- To provide the knowledge about Adaptive Control and case studies

MODULE - I **15**

Multivariable Systems: Multivariable Systems – Transfer Matrix Representation – State Space Representation – Poles and Zeros of MIMO System - Multivariable frequency response analysis - Directions in multivariable systems - Singular value decomposition

Multi-Loop Regulatory Control: Multi-loop Control - Introduction – Process Interaction – Pairing of Inputs and Outputs -The Relative Gain Array (RGA) – Properties and Application of RGA - Multi-loop PID Controller – Biggest Log Modulus Tuning Method - Decoupling Control – LQG Control – RGA for Non-square Plant

MODULE - II **15**

Multivariable Regulatory Control: Introduction to Multivariable control –Multivariable IMC– Multivariable Dynamic Matrix Controller -Multivariable Model Predictive Control –Generalized Predictive Controller – Multiple Model based Predictive Controller – Constrained Model Predictive Controller - Implementation Issues

Control of Time-Varying and Nonlinear Systems: Models for Time-varying and Nonlinear systems –Real-time parameter estimation

MODULE- III **15**

Adaptive Control: Types of Adaptive Control - Gain scheduling - Adaptive Control - Deterministic Self-tuning Controller and Model Reference Adaptive Controller – Nonlinear PID Controller

Case–Studies: Control Schemes for Distillation Column, CSTR, Bioreactor, Three-tank hybrid system, Four-tank system, pH, and polymerization reactor.

TOTAL: 45

REFERENCE BOOKS

1. Bequette, B.W., "Process Control Modeling, Design and Simulation", Prentice Hall of India, 2004
2. Stephanopoulos, G., "Chemical Process Control - An Introduction to Theory and Practice", Prentice Hall of India, 2005
3 Seborg, D.E., Edgar, T.F. and Mellichamp, D.A., "Process Dynamics and Control", Wiley John and Sons, 2nd Edition, 2003
4 Coughanowr, D.R., "Process Systems Analysis and Control", McGraw -Hill international Edition, 2004
5 E. Ikonen and K. Najim, " Advanced Process Identification and Control", Marcel Dekker, Inc. Newyork, 2002
6 P. Albertos and S. Antonio, " Multivariable Control Systems An Engineering Approach", Springer Verlag, 2004

11CI203 INDUSTRIAL DATA NETWORKS

3 0 0 3

Objectives:

- To Identify, prevent and troubleshoot industrial communications problems
- To Gain a practical toolkit of skills to troubleshoot industrial communications
- To understand Ethernet and TCP/IP network

MODULE- I **15**

Modern instrumentation and control systems -Open systems interconnection (OSI) model -Protocols – Standards- EIA-232 overview -EIA-232 interface standard (CCITT V.24 interface standard) - The major elements of EIA-232 -Half-duplex operation of the EIA-232 interface - RS-485 overview - The RS-485 interface standard -RS-485 vs RS-422-Current loop and RS-485 converters -- The 20 mA current - Serial interface converters

MODULE - II **15**

Modbus - Modbus protocol - Function codes -- Modbus Plus protocol overview - HART Introduction to HART and smart instrumentation HART protocol - AS-interface (AS-i)
DeviceNet - ProfiBus PA/DP/FMS- Foundation Fieldbus

MODULE- III **15**

Industrial Ethernet: 10 Mbps Ethernet- 100 Mbps Ethernet- Gigabit Ethernet- Industrial Ethernet- TCP/IP: Internet layer protocols (packet transport)- Host-to-host layer: End to end reliability- Radio and wireless communications: Components of a radio link - The radio spectrum and frequency allocation -Summary of radio characteristics of VHF/UHF - Radio modems- Implementing a radio link

TOTAL: 45

REFERENCE BOOKS

1. Steve Mackay, Edwin Wright ,Deon Reynders," Practical Industrial Data Networks: Design,Installation and Troubleshooting" Elsevier,2004 .
2. Computer Networks and Internets (Douglas E. Corner) Pearson Education Asia, 5th Indian reprint –2001 (2nd Edition).
3 Practical Industrial Data Communications (Deon Reynders, Steve Mackay, Edwin Wright). Elsevier –2005 (1st Edition)
4 Industrial Data Communication (Lawrence M. Thompson) 1997 (2nd Edition).
5 Data Communications and Networking (Behrouz A. Forouzan) Tata McGraw Hill Publishing Co. −New Delhi – 2000 (2nd Edition).

11CI204 INDUSTRIAL AUTOMATION LABORATORY

0 0 3 1

LIST OF EXPERIMENTS

1. Study of Programmable Logic Controller
2. Control of Bottle Filling System using PLC
3. Material Handling System using PLC
4. Pneumatic Stamping System using PLC
5. Traffic Light Control using PLC
6. Design and Development of Annunciator circuit using PLC
7.Development of HMI using SCADA
8. DCS for level process
9. DCS for pressure process
10. DCS for flow process
11. DCS for cascade process
12. DCS for Split Range Control

11CI205 ADVANCED PROCESS CONTROL LABORATORY

0 0 3 1

LIST OF EXPERIMENTS

1. Modeling of single capacity level process from Process Reactive curve. Obtain PID Tuning parameters from the model.
2. Modeling of Two capacity interacting and non interacting level Processes
3. Characteristic study of linear, equal percentage and quick opening valves.
4. Heat transfer in Compact Heat exchanger
5. Distillation Column
6. Control of process using multiloop controller with SCADA.
7. Design of digital controller using Deadbeat Algorithm
8. Design of digital controller using Dalhin's Algorithm
9. Design of digital controller using Kalman's Algorithm
10. Design of Smith Predictor algorithm
11. Design of Predictive controller
12. Characteristic of Flapper Nozzle arrangement & Differential Pressure Transmitter.

11AE016 ELECTRONIC PRODUCT DESIGN

(Common to M.E.Applied Electronics, Control and Instrumentation)

3 0 0 3

PREREQUISITE

Electronic Circuits , Digital Electronics

Objective:

- To introduce the basic Electronic Product Design
- To impart the knowledge about the System Design
- To understand the concept of Packaging and Quality control
- To develop the portable electronic system design ideas

MODULE - I **15**

Introduction: The basic product development process-product planning-design and engineering-procurement-manufacturing -functionality-performance-user interface-form factor- battery life- cost-time to market (TTM)- reliability-marketing and distribution-service and support.

System Design: Top down design-product concept-innovation-creativity- validation -communication-product requirements-system architecture development-trade-off analysis-cost modelling-circuit design-physical and mechanical design-Tolerance and reliability.

MODULE - II **15**

System Design: system architecture development-trade-off analysis-cost modelling-circuit design-physical and mechanical design-Tolerance and reliability

Electronic Packaging: IC packaging: Leaded package, TABITCP package-COB, flip-chip, BGA, CSP-Discrete components-Board to board connectors-substrates-Escape routing-PCA/module design metrics-Electronic packaging metrics-I/o hardware : buttons, switches, dials and touch screens, speakers , microphones, antennas, and external connectors

Mechanical Design: Housings-EMI shielding-Thermal management: High level thermal analysis, thermal issues in notebook computers-mechanical integration-DFMA analysis

MODULE - III **15**

Quality in the Design Process: Quality control -quality assurance-quality functional deployment-assignment matrices-checklist-quality in the design process-concurrent design-risk analysis-quality in production.

Portable Electronics: Digital and analog processing: microprocessor, logic devices, microcontrollers, DSP, analog devices, sensors, wireless communication, system memory and mass storage-Displays: Display technologies-LCD-micro display-pen input-power sources- Battery technologies: Ni-Cd, alkaline,Ni-MH,lithium ion, lithium polymer, photovoltaic cells, fuel cells-product implementation-high level power analysis-Case study**:** Cellular phones-portable PCs-Personal digital assistants-digital imaging products.

TOTAL: 45

REFERENECE BOOKS

1. Tony Ward and James Angus, ”Electronic Product Design”, Chapman and Hall publications,1996
2. Bert Haskell, “Portable Electronics Product Design and Development: for cellular phones, PDAs, Digital cameras, personal electronics and more”, McGraw-Hill, New York, 2004.

11AE017 INDUSTRIAL ELECTRONICS

(Common to Mechatronics, Applied Electronics and Control and Instrumentation Engg)

3 0 0 3

Objectives:

- To familiarize the Mechatronics students with power electronics and its applications in Industries
- To get an overview of different types of power semiconductor devices and phase controlled rectifiers
- To study the basic topologies in DC-DC converters and inverters

MODULE - I **16**

Power Electronic Devices and Converters: Principle of operation – Characteristics of power diodes, SCR, TRIAC, GTO, Power BJT, Power MOSFET and IGBT – Thyristor protection circuits. Phase controlled Rectifiers: Single phase full converters – Three phase half and full converters – Triggering circuits. Inverters – PWM techniques – Sinusoidal PWM, modified sinusoidal PWM and multiple PWM.

MODULE - II **12**

DC-DC and AC-AC Converters: Chopper: Principle of operation – Step up and step down chopper – Control Strategies –Voltage, Current and Load commutated chopper. AC voltage Controller: Principle of single phase AC voltage controller – Phase control – ON-OFF control – Multistage sequence control – Cycloconverters - Step up and step down operation - Three phase to single phase and three phase to three phase cycloconverters.

MODULE - III **15**

Solid State DC and AC Drives: Constructional details, principle of operation and performance characteristics of DC motors – DC motor control using rectifiers and choppers – AC drives - Constructional details, principle of operation and performance characteristics of single phase induction motor, three phase induction motor – Control of induction motor by V, V/f and slip power recovery scheme using inverters and AC power regulators.

TOTAL: 45

REFERENCE BOOKS

1. Rashid, M. H., “Power Electronics: Circuits Devices and Applications”, Third Edition, Prentice Hall International, New Delhi, 2004.
2. Mohan, Ned, Undeland and Robbins, “Power Electronics”, John Wiley and Sons, New York, 2002.
3. Singh, M. D. and Khanchandani, K. B., “Power Electronics”, Second edition, Tata McGraw-Hill, New Delhi, 2007.
4. Dubey, G. K., “Fundamental Electric Drives”, Second Edition, Narosa Publications, 2002.
5. Dubey, G. K., “Power Semiconductor Controlled Drives”, Prentice Hall International, New York, 2001.

11AE018 INDUSTRIAL ROBOTICS

(Common to M.E.Applied Electronics, Control and Instrumentation)

3 0 0 3

PREREQUISITE

Sensors and Transducers

Objectives:

- Introduction and Basics to Robotics.
- To understand the concepts of Robotics power transmission systems
- To study the characteristics and various types of sensors.
- To learn the concept of the vision systems for robotics and various types of standards.
- To study the architecture of PLC and various types of PLCs and its automation.

MODULE - I **15**

Robotics and Robotics Drives: History, Present status and future trends in Robotics and automation – Application Laws of Robotics - Robot definitions - Robotics systems and robot anatomy - Specification of Robots - resolution, repeatability and accuracy of a manipulator. Robotics applications Robot drive mechanisms, hydraulic – electric – servomotor- stepper motor - pneumatic drives.

Robotics Power Transmission Systems: Mechanical transmission method - Gear transmission, Belt drives, cables, Roller chains, Link - Rod systems - Rotary-to-Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearing screws, Harmonic drives.

MODULE - II **15**

End effectors: Types of End Effector, Mechanical gripper, Types of Mechanisms, Magnetic gripper, Vaccum gripper, other types of gripper.

Rigid Transformation: Rigid motions and Homogeneous transformations, Kinematic chaim, Denavit – Harten berg representation, Forward and Inverre Kinematics, Velocity Kinematics, Manipulator Dynamics.

End effectors – Types.

MODULE- III **15**

Sensors: Sensor characteristics, Position sensors – Potentiometers – Encoders – Resolvers – LVDT, Velocity sensors – Tachogenerators - Encoders - Proximity sensors, Limit switches – Tactile sensors - Touch sensors - Force and torque sensors

Vision Systems for Robotics: Robot vision systems, Image capture- cameras – vidicon and solid state, Image representation - Gray scale and colour images, image sampling and quantization - Image processing and analysis - Image data reduction - Segmentation - Feature extraction - Object Recognition- Image capturing and communication - JPEG, MPEGs and H.26x standards, packet video, error concealment.- Image texture analysis. This is all comes under robot dynamics control without knowledge of Kinematics insister pastille to understood .

TOTAL: 45

REFERENCE BOOKS

1. Klafter, Richard D., Chmielewski, Thomas A, and Negin, Michael., "Robotics Engineering: An Integrated Approach", Prentice Hall of India, New Delhi, 1989.
2. Fu, K.S., Gomalez, R.C., and Lee C.S.G., "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill, New York, 1987.
3. Robot Dynamics and control matrix W. Spong M. Vidyasagar. Wiley Publication.

11AE020 MICRO SENSORS AND MEMS

(Common to M.E.Applied Electronics and Control and Instrumentation Engineering)

3 0 0 3

Objective:

- To gain a fundamental knowledge of standard Microsystems design fabrication and manufacturing techniques.
- Understanding the working principles of micro sensors and actuators
- The materials used for MEMS system design and its properties.
- Know the major classes, components and application of MEMS systems.

MODULE-I **15**

Introduction to Microsystems and Micro Electronics working principles of different types of Micro sensors and Micro actuators scaling laws for Micro system design – Mechanics for MEMS design: Bending of thin plates, Vibration and fracture mechanics

MODULE-II **15**

Materials for MEMS: Si, Silicon compounds: Sio_2, Si_3N_4, SIC,Poly silicon, Silicon Piezo resistors – GAS, Quartz, polymers – Piezo Electric crystels. Fabrication: Photolithography, Ion implantation, diffusion, oxidation, CVD, Sputtering, etching.

MODULE-III **15**

Microsystem manufacturing and packaging : Bulk micro machining, surface micro machining, LIGA Technique – Die level, device level and system level practices – Application ;of Microsystems in automotive industry, biomedical and consumer products.

TOTAL: 45

TEXT BOOKS

1. Doebelin, E.O., "Measurement Systems: Application & Design", Fifth Edition McGraw-Hill Book Co., New Delhi, 2004.
2. Sheingold, D.H., "Transducer Interfacing Handbook: The guide to analog signal conditioning", Analog devices Inc.,

REFERENCE BOOKS

1. Tai – Ran Hsu, " MEMS and Microsystems design and manufactures" Tata McGraw Hill, New Delhi, 2008.
2. Mohamed Gad –el-Hak, "The MEMS Hand Book", CRC press, 2002.
3. Fatilcow. S and Rembold U, "Microsystem Technology and Microrobotics, Springe – verlog Berlin, 1997.
4. Garden, J.W. Varadan.V.K., Osama and Awadelkarim.O., "Microsensors MEMS and Smart Devices", John Wiley & sons Ltd., New York, 2001.

11AE103 ADVANCED DIGITAL SYSTEM DESIGN

(Common to M.E. Applied Electronics, Control and Instrumentation)

3 1 0 4

Objective:

- To become familiarize in synchronous and asynchronous logic design
- To introduce the concept of FPGA
- To understand the concept of fault Modeling, Fault Testing and related algorithms
- To study the fault diagnosis methods in VLSI circuits

MODULE – I **15**

Advanced Topic in Sequential Logic Design: ASM Chart – ASM Realization for Synchronous Logic circuit -Analysis of Asynchronous Sequential Circuit (ASC) – Flow Table Reduction – Races in ASC – State Assignment – Problem and the Transition Table – Design of ASC – Static and Dynamic Hazards – Essential Hazards

System Design Using VHDL: VHDL Description of Combinational Circuits – Arrays – VHDL Operators – Compilation and Simulation of VHDL Code – Modeling using VHDL – Flip Flops – Registers

MODULE - II **15**

System Design Using VHDL: Counters – Sequential Machine – Combinational Logic Circuits - VHDL Code for – Serial Adder, Binary Multiplier – Binary Divider – complete Sequential Systems – Design of a Simple Microprocessor

Field Programmable Gate Arrays: Types of FPGA - XILINX XC3000 series - Logic Cell Array (LCA) – Configurable Logic Blocks (CLB) - Input/Output Blocks (IOB) - Programmable Interconnection Points (PIP) - XILINX XC4000 Series –Introduction to Xilinx SPARTAN, VIRTEX FPGA – Design examples

Fault Modeling and Simulation: Introduction to Testing - Faults in digital circuits - Modeling of faults

MODULE -III **15**

Fault Modeling and Simulation: Logical Fault Models - Fault detection - Fault location - Fault dominance - Logic Simulation - Types of simulation - Delay models - Gate level Event-driven simulation

Fault Diagnosis and Testability Algorithms: Fault Table Method – Path Sensitization Method – Boolean Difference Method – D Algorithm – Tolerance Techniques – The Compact Algorithm – Practical PLA's – Fault in PLA – Test Generation – Masking Cycle – DFT Schemes – Built-in Self Test

Lecture : 45, Tutorial : 15, TOTAL : 60

REFERENCE BOOKS

1. Charles H Roth, "Digital Systems Design Using VHDL," Thomson Asia,. 2004
2. Palmer, J.E., Perlman, D.E., "Introduction to Digital Systems",Tata McGraw Hill, New Delhi, Reprint 1996
3 Michael L Bushnell, Vishwani D Agrawal, "Essentials of Electronic Testing For digital memory and mixed signal VLSI circuits", Kluwer academic Publications, USA, 2001
4 Yarbrough, John M., "Digital Logic Applications and Design", Thomson Learning, 2001.
5 Lala, P.K., "Digital Circuit Testing and Testability", Academic Press, 2002.

11CI011 ADVANCED INSTRUMENTATION SYSTEM DESIGN

3 1 0 4

Objectives:

- To introduce the design of signal conditioning circuits
- To introduce the design of Transmitters
- To introduce the design of Pneumatic and Electronic Controller
- To introduce the design of Orifice and Control Valve Sizing

MODULE - I **15**

Design of signal conditioning circuits

Design of V/I Converter and I/V Converter- Analog and Digital Filter design –Signal conditioning circuit for thermocouple - Cold Junction Compensation Thermocouple Linearization – Signal conditioning circuit for RTD

Design of Transmitters

RTD based Temperature Transmitter – Thermocouple based Temperature Transmitter- Design of Capacitance based Level Transmitter – Air-purge Level Measurement – Design of Smart Flow Transmitters.

MODULE - II **15**

Design of Pneumatic and Electronic Controller

Design of P/I and I/P convertor -Design of ON/OFF Controller using Linear Integrated Circuits- Electronic P,I,PI,PID Controller – cascade and feed forward controller -Microcontroller Based Digital PID Controller - Alarm and Annunciation circuits using Analog and Digital Circuits – Thyristor Power Controller

MODULE - III **15**

Orifice and Control Valve Sizing

Orifice Sizing - Liquid, Gas and steam services – Rotameter Design. Control Valves – Valve body: - Commercial valve bodies –Control valve sizing– Liquid, Gas and steam Services – Cavitations and flashing –Selection criteria.

Lecture: 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS

1. C. D. Johnson, "Process Control Instrumentation Technology", 8th Edition, Prentice Hall, 2006.
2. Control Valve Handbook, 4th Edition, Emerson Process Management, Fisher Controls International, 2005
3. Instrumentation Devices and Systems- Rangan, Sharma, Mani-Tata McGraw-Hill 2nd. Edition.
4. D. Roy Choudhury, Shail B.Jain " linear Integrated Circuits", New AGE International Publishers,Fourth Edition,2010

11CI012 APPLIED INDUSTRIAL INSTRUMENTATION

3 0 0 3

Objectives:

- To review the measurements of important Process variables in Industrial Instrumentation.
- To learn the selection, installation and maintenance of Process Instruments in Thermal Power Plant.
- To learn the measurements of variables in Petrochemical Industry.
- To enhance the knowledge about the instrumentation for energy conservation, management and safety.
- To study the special purpose instrumentation.

MODULE – I **15**

Review of Industrial Instrumentation: Measurement of Force, Torque, Velocity, Acceleration, Pressure, Temperature, Flow, Level, Viscosity, Humidity & Moisture (Qualitative Treatment Only).

Measurement in Thermal Power Plant: Selection, Installation and maintenance of Instruments used for the measurement of Fuel flow, Air flow, Drum level, Steam pressure, Steam temperature and other parameters in Thermal Power Plant.

Analyzers-Dissolved Oxygen Analyzers- Flue gas Oxygen Analyzers-pH measurement- Coal/Oil Analyzer –. Pollution Controlling Instruments:

MODULE - II **15**

Measurement in Petrochemical Industry: Parameters to be measured in Refinery and Petrochemical industry-Temperature, Flow and Pressure measurements in Pyrolysis, Catalytic cracking, Reforming processes-Selection and maintenance of measuring instruments.

Instrumentation for Energy Conservation & Management: Energy measurement techniques-Principle of energy audit, Management & Conservation– Energy management device (Peak load shedding)-Energy Efficiency Rating-Instrumentation for Renewable energy systems.

MODULE - III **15**

Instrumentation for Safety: Electrical and Intrinsic Safety - Explosion Suppression and Deluge systems – Flame arrestors, Conservation vents and Emergency vents – Flame, Fire and Smoke Detectors- Metal detectors- Leak Detectors.

Special Purpose Instrumentation: Toxic gas monitoring– Water quality monitoring- Detection of Nuclear radiation-Thermo-luminescent detectors – Measurement of length, mass, thickness, flow, level using nuclear radiation.

TOTAL : 45

REFERENCE BOOKS

1. Liptak B.G, “Instrumentation Engineers Handbook (Process Measurement and Analysis)”, CRC Press, Volume I, Fourth Edition, 2003.
3. William G. Andrew, H. B. Willams, “Applied Instrumentation in the Process Industries”, Gulf Professional Publishing; II Edition 1979.
4. Krishnaswamy. K, and Vijayachitra.S., “Industrial Instrumentation”, New Age International Publishers, New Delhi, 2004.
5. Patranabis D., “Principles of Industrial Instrumentation”, Tata McGraw Hill, New Delhi, 1999.

11CI013 MICROCONTROLLER BASED SYSTEM DESIGN

3 0 0 3

Objectives:

To impart knowledge on

- 8051 Microcontroller based system design.
- Microchip PIC 8 bit microcontroller based system Design

MODULE - I **15**

8051 Architecture and Programming: Architecture – memory organization – addressing modes – instruction set – Timers - Interrupts - I/O ports, Interfacing I/O Devices – Serial Communication Assembly language programming – Arithmetic Instructions – Logical Instructions –Single bit Instructions – Timer Counter Programming – Serial Communication Programming- Interrupt Programming – RTOS for 8051 – RTOSLite – FullRTOS –Task creation and run – LCD digital clock/thermometer using FullRTOS

MODULE - II **15**

PIC Microcontroller and its Peripherals: Architecture – memory organization – addressing modes – instruction set – PIC programming in Assembly & C –I/O port, Data Conversion, RAM & ROM Allocation, Timer programming- Timers – Interrupts, I/O ports- I^2C bus-A/D converter-UART- CCP modules

MODULE - III **15**

System Design – Case Study: ADC, DAC and Sensor Interfacing –Flash and EEPROM memories-Interfacing LCD Display – Keypad Interfacing - Generation of Gate signals for converters and Inverters - Motor Control – Controlling AC appliances –Measurement of frequency - Stand alone Data Acquisition System

TOTAL: 45

REFERENCE BOOKS

1. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey ‘ PIC Microcontroller and Embedded Systems using Assembly and C for PIC18’, Pearson Education 2008
2. John Iovine, ‘PIC Microcontroller Project Book ’, McGraw Hill 2000
3. Myke Predko, “Programming and customizing the 8051 microcontroller”, Tata McGraw Hill 2001.

11CI014 ROBUST CONTROL

3 0 0 3

Objectives:

- To provide basic concepts of robust and H-infinity control theory
- To introduce modern multivariable robust control methods
- To give emphasis on closed loop system design techniques insensitive to modeling errors.

MODULE – I **15**

Introduction and Background: Introduction to concepts of model uncertainty, including both parametric and dynamic un-certainty. Fundamental concept of robustness and the relationship between physical systems and mathematical models. Mathematical background including norms for vectors, matrices, signals, and systems. The singular value decomposition and its application to perturbation analysis.

MODULE - II **15**

Robustness Problems: Linear fractional transformations and canonical forms. Performance measured via (induced) norms. Robust stability and performance problems. Solution of SISO robustness problems.

Computer-Aided Analysis Techniques: Introduction to the structured singular value for robustness analysis of MIMO systems. Conversion of robustness problems to canonical M-Δ form. The small gain theorem and approximate computation of μ via effiμcient upper and lower bounds. Computer-aided tools for μ analysis based on the μ Tools Matlab toolbox.

MODULE - III **15**

Synthesis and Controller Design: Optimal controller design including H_2 and $H\infty$ optimal control. Scaled $H\infty$-optimal control problems and μ synthesis. Computer-aided tools to implement D,G-K iteration for advanced controller design.

Design case studies: Control of an inverted pendulum-continuously stirred tank - aircraft

TOTAL : 45

REFERENCE BOOKS

1. Robust Control Systems-U.Mackenoth,Springer, Verlag, London 2010.
2. Essentials of Robust Control: K. Zhon, John C. Doyle, Prentic Hall Int. 1998
3. Robust Control - The Parametric Approach: S. P. Bhattacharya, H. Chapellat, Prentice Hall Int.1995
4. A Course in H∞ Control Theory: Francis
5. Robust and H∞ Control: Ben M. Chen, Springer Verlag, London, 2000

11CI015 OPTIMAL CONTROL THEORY

(Common to M.E.Control and Instrumentation Engineering, Power Electronics and Drives)

3 1 0 4

Objectives:

- To introduce the basics about linear optimal control and dynamic programming.
- To enhance the knowledge about Calculus of Variations and The Minimum (Maximum) Principle.

MODULE - I **15**

Introduction: Review: state space representation, matrix theory, static optimization with and without constraints. Calculus of variations-basic concepts-functionals of a single function and several functions-necessary conditions and boundary conditions

Optimal control formulation:The performance measures for optimal control problems-Hamiltonian approach-necessary conditions for optimal control-and Linear regulator problem-infinite time regulator problem-, Regulators with a prescribed degree of stability.

MODULE - II **15**

The Minimum (Maximum) Principle: Pontryagin's minimum principle and state inequality constraints, Minimum time problem, Minimum control energy problems. Singular intervals in optimal control.

Numerical Techniques: Numerical solution of two-point boundary value problem –Gradient method and Quasi Linearisation method - solution of Ricatti equation by iterative method.

MODULE- III **15**

Dynamic Programming: Principle of optimality - recurrence relation of dynamic programming for optimal control problem - computational procedure for solving optimal control problems - characteristics of dynamic programming solution - dynamic programming application to discrete and continuous systems - Hamilton Jacobi Bellman equation. Relationship between Dynamic Programming and Minimum Principle.

Lecture:45, Tutorial:15, TOTAL: 60

REFERENCE BOOKS

1. Kirk Donald, "Optimal Control Theory", Prentice Hall, New Jersey, 1970.
2. Anderson B.D.O. and Moore J.B., "Optimal Control: Linear Quadratic Methods", Prentice Hall, New Jersey, 1979.
3 Desineni Subburam Naidu, "Optimal Control Systems", CRC Press,2003
4 Anderson B.D.O. and Moore J.B., "Optimal Control: Linear Quadratic Methods", Prentice Hall, New Jersey, 1979.

11CI016 ADAPTIVE CONTROL THEORY

3 1 0 4

Objectives:

- To provide introduction to parameter adaptation algorithms,
- To introduce the concept of model reference adaptive control, self-tuning control systems, stability and convergence of adaptive algorithms,
- To impart implementation aspects of adaptive control, and applications.

MODULE - I **15**

System Identification: Introduction, dynamic systems, models, system identification procedure. Simulation and Prediction. Non-parametric time and frequency domain methods.

Linear dynamic system Identification: Overview, excitation signals, general model structure, time series models, models with output feedback, models without output feedback. Convergence and consistency.

MODULE - II **15**

State estimation and Observers: Parameter estimation methods, minimizing prediction errors, linear regressions and Least squares method, Instrumental – variable method, prediction error method. Recursive algorithms. Closed-loop Identification. luenberger asymptotic observers – adaptive observers – extended recursive least squares – FM and Kalman filter

MODULE- III **15**

Adaptive Control: Close loop and open loop adaptive control. Self-tuning controller Auto tuning for PID controllers: Relay feedback, pattern recognition, correlation technique.

Adaptive Smith predictor control: Auto-tuning and self-tuning Smith predictor. Adaptive advanced control: Pole placement control, minimum variance control, generalized predictive control.

Lecture:45, Tutorial:15, TOTAL: 60

REFERENCE BOOKS

1. Chang C. Hong, Tong H. Lee and Weng K. Ho, Adaptive Control, ISA press, Research Triangle Park, 1993
2. Nelles. O, Nonlinear System Identification, Springer Verlag, Berlin, 2001
3 Ljung .L, System Identification: Theory for the user, Prentice Hall, Englewood Cliffs,1987
4 Astrom .K, Adaptive Control, Second Edition, Pearson Education Asia Pvt Ltd, 2002
5 Sastry S. and Bodson M. Adaptive control Stability, Convergence and Robustness, Prentice Hall, 1989

11CI017 BIO-MEDICAL SIGNAL PROCESSING

3 0 0 3

PREREQUISITE

Digital Signal Processing, Bio Medical Instrumentation

Objective:

- To study the various bio medical signals and filtering concepts
- To study the various modeling concepts of biomedical systems
- To analyze the characteristics of non-stationary signals and systems
- To analyze and study the pattern classification and compression technique
- To introduce the concepts of wavelet, image processing, neural networks and VLSI in biosignal processing

MODULE- I **15**

Biomedical Signals, Filtering and Modelling: Nature of Biomedical signals, Types: Action Potential, Electroneurogram (ENG), Electromyogram (EMG), Electrocardiogram (ECG), Electroencephalogram (EEG), Event related potentials, Electrogastrogram (EGG), Phonocardiogram (PCG), Speech signals.

Stationary versus non-stationary processes, Time domain filters, Frequency domain filters, Optional filters, Adaptive filters for removal of Interference, Selection of Appropriate filters, Applications.

Parametric System modeling, Autoregressive or All-pole modeling, Pole-zero modeling, Electromechanical Models of Signal Generation, Application: Heart – rate variability – Spectral modeling and Analysis of ECG signals.

MODULE- II **15**

Non Stationary Signals, Classification and Decision: EEG rhythms and waves, characterization of non stationary signals and dynamic systems, Fixed segmentation, Adaptive segmentation

Supervised, Unsupervised Pattern classification, Probabilistic models and Statistical Decision, Regression analysis.

MODULE- III **15**

Compression and Advanced Topics: Direct Digital compression Techniques, Transformation Compression Techniques, Other Compression Techniques and Comparison

Introduction to Wavelet Transforms, Application of Wavelet Transform on Biomedical Signals, Multi Resolution Analysis. Neural Networks in Processing and Analysis of Bio medical Signals, Image Processing Algorithms for MRI Images. VLSI in Biosignal processing.

TOTAL: 45

REFERENCE BOOKS

1. Rangaraj M. Rangayyan, "Biomedical Signal Analysis, A case study Approach," IEEE Press, 2001.
2. Bronzino Joseph D, "The Biomedical Engineering Handbook, CRC Press, IEEE Press, 2000.
3. Reddy D.C., "Biomedical Signal Processing, Principles and Techniques",Tata McGraw Hill, New Delhi, 2005
4. Banner Kenneth E and Arce Gonzalo R "Nonlinear Signal and Image Processing: Theory Methods and Applications", CRC Press, New York, 2003
5. Akay Metin "Nonlinear Bio Medical Signal Processing', IEEE Press, 2000.

11CI018 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

3 0 0 3

Objectives:

- To introduce the basics about EMI and Method of Hardening.
- To enhance the knowledge about Balancing, Filtering and Shielding and Digital Circuit Noise and Layout.
- To provide the knowledge about Electrostatic Discharge, Standards And Laboratory Techniques.

MODULE - I **15**

Introduction: Sources of EMI, Conducted and radiated interference- Characteristics - Designing for electromagnetic compatibility (EMC)- EMC regulation- typical noise path- use of network theory- methods of eliminating interferences.

Method of Hardening: Cabling –capacitive coupling- inductive coupling- shielding to prevent magnetic radiation- shield transfer impedance, Grounding – safety grounds – signal grounds- single point and multipoint ground systems- hybrid grounds- functional ground layout –grounding of cable shields- ground loops-guard shields.

MODULE - II **15**

Balancing, Filtering and Shielding: Power supply decoupling- decoupling filters-amplifier filtering –high frequency filtering-shielding –near and far fields- shielding effectiveness- absorption and reflection loss, Shielding with magnetic material- conductive gaskets, windows and coatings- grounding of shields.

Digital Circuit Noise and Layout: Frequency versus time domain- analog versus digital circuits- digital logic noise- internal noise sources- digital circuit ground noise –power distribution-noise voltage objectives- measuring noise voltages-unused inputs-logic families.

MODULE- III **15**

Electrostatic Discharge, Standards And Laboratory Techniques: Static Generation- human body model- static discharges-ED protection in equipment design- ESD versus EMC, Industrial and Government standards – FCC requirements – CISPR recommendations-Laboratory techniques- Measurement methods for field strength-EMI

TOTAL: 45

REFERENCE BOOKS

1. Henry W.Ott, " Noise reduction techniques in electronic systems", John Wiley & Sons, 1989
2. Bernhard Keiser, "Principles of Electro-magnetic Compatibility", Artech House, Inc. (685 canton street, Norwood, MA 020062 USA) 1987
3 Bridges, J.E Milleta J. and Ricketts.L.W., "EMP Radiation and Protective techniques", John Wiley and sons, USA 1976
4 IEEE National Symposium on "Electromagnetic Compatibility", IEEE, 445, hoes Lane, Piscataiway, NJ 08855

11CI019 STATE AND PARAMETER ESTIMATION

3 0 0 3

Objectives:

- To get an overview of state estimation and kalman filter.
- To know in detail about H- infinity filter
- To know about particle filter and parameter estimation

MODULE- I **15**

Introduction to state estimation and Kalman filter: Review of Matrix Algebra and Matrix Calculus and Probability Theory – Least Square Estimation – Review of state observers for Deterministic System- Derivation of the Discrete – time Kalman filter – Kalman filter properties- Kalman filter generalization: - Correlated Process and Measurement Noise – Case Studies

Extended Kalman filter: Linearized Kalman filter – Extended Kalman filter – The iterated Extended Kalman filter – The Second order Extended Kalman filter

MODULE - II **15**

Unscented Kalman filter: Means and Covariance of non-linear transformations – Unscented transformation –Unscented Kalman filtering -General - Unscented transformation - The simplex Unscented transformation – Spherical Unscented transformation - Constrained Unscented Kalman filter – Case Studies

The H-infinity filter: The H- infinity filter -Introduction - Kalman filter Limitations - A game theory Approach to H- infinity filtering – Steady state H- infinity Filtering -Mixed Kalman / H-Infinity filtering – Robust Kalman / H- infinity filtering - Constrained H- infinity filtering – Case Studies

MODULE- III **15**

Particle filter

Bayesian state Estimation - Particle filtering - Implementation issues: - Sample Impoverishment - Particle filter with EKF as proposal - Unscented Particle filter - Case Studies

Parameter Estimation

Bayesian estimation: MMSE estimation- MAP estimation- Maximum likelihood estimation- Unbiased linear MMSE estimation. Performance of estimators. Data fitting: Least squares fitting- Fitting using a robust error norm- Regression

TOTAL: 45

TEXT BOOKS

1 Branko Ristic, Sanjeev Arulampalam, Neil Goodon, "Beyond the Kalman Filter: Particle ilters for Tracking Application" Artech House Publishers, Boston,London, 2004.

2. Dan Simon, "Optimal State Estimation Kalman, H-infinity and Non-linear Approaches", John Wiley and Sons, 2006.

3 W.L. Luyben, "Process Modelling, Simulation and Control for Chemical Engineers", 2nd Edn., McGraw Hill Book Co., New York, 1990

11CI020 DRIVES ANDCONTROL

3 0 0 3

Objectives:

- To introduce the basics about Converter FED DC Drives and Chopper FED DC Drives.
- To enhance the knowledge about Inverter FED Induction Motor Drive and Mathematical Modeling of Frequency Controlled Drive
- To provide the knowledge about Closed Loop Control of Microcomputer Based Drives

MODULE - I **15**

Converter FED DC Drives: Microcontroller hardware circuit, flow charts waveforms, Performance characteristics of dc drives fed through single phase converters, 3-phase converters, dual converters, 1-phase fully controlled converter and 3-phase fully controlled converter fed dc drive.

Chopper FED DC Drives: Microcontroller hardware circuits and waveforms of various modes of operation of chopper fed DC drives.

MODULE - II **15**

Inverter FED Induction Motor Drive: Microcomputer controlled VSI fed induction motor drive - Detailed power circuit, generation of firing pulses and firing circuit, flow charts and waveforms for 1-phase, 3-phase Non-PWM and 3-phase PWM VSI fed induction motor drives. Sampling techniques for PWM inverter.

Mathematical Modeling of Frequency Controlled Drive: Development of mathematical model for various components of frequency controlled induction drive, mathematical model of the system for steady state and dynamic behaviour, Study of stability based on the dynamic model of the system.

MODULE- III **15**

Closed Loop Control of Microcomputer Based Drives: Voltage, Current, Torque and Speed measurements using digital measurement techniques. Types of controllers, position and velocity measurement algorithm, closed loop control of microcomputer based drives.

TOTAL: 45

REFERENCE BOOKS

1. Bose.B.K., Power Electronics and Motor Drives - Advances and Trends, IEEE Press, 2006
2. Buxbaum, A. Schierau, and K.Staughen, “A design of control systems for DC drives”, Springer-Verlag, Berlin,1990
3 Thyristor control of Electric drives, Vedam Subrahmanyam, Tata McGraw Hill, 1988.
4 R.Krishnan, “Electric Motor Drives, Modeling, Analysis and Control” Prentice Hall of India, 2002
5 Bin Wu, “High Power Converters and AC Drives”, IEEE Press, A John Wiley and Sons, Inc., 2006
6 Dubey G.K., Power semiconductor controlled drives, Prentice-HALL 1989
7 Control of Electric Drives, Leonard W, Springer Verlag, NY, 1985
8 Bose B.K., Microcomputer control of power electronics and drives, IEEE Press, 1987

11CI021 ADVANCED DIGITAL IMAGE PROCESSING

3 0 0 3

Objectives:

- To introduce the fundamentals and techniques of digital image processing.
- To understand the various 2D image transformations.
- To study the concepts of image processing techniques like image enhancement and restoration.
- To study the various techniques in image segmentation and representation.
- To understand the various technique of Image compression and its standards

MODULE– I **15**

Introduction: Elements of Digital Image processing – Elements of visual perception: light - luminance – brightness, contrast, hue, saturation – Mach band effect – simultaneous contrast. Color image fundamentals – RGB model and HIS model – converting colors from HIS to RGB. Two dimensional sampling theory.

Image Transforms: Two dimensional systems - Block matrices and Kronecker products. Two dimensional orthogonal and unitary transforms – DFT, cosine, sine, Walsh, problems

MODULE– II **15**

2D Transforms: Hadamad, Haar and KL transforms, Radon transforms, problems

Image Enhancement and Restoration: Image enhancement - Point operations - contrast stretching - clipping and thresholding - digital negative intensity level slicing - bit extraction. Histogram processing - histogram equalisation -modification. Spatial operations – smoothing spatial filters, sharpening spatial filters. Transform operations. Color image enhancement. Image Restoration – degradation model, Unconstrained and Constrained restoration, Inverse filtering – removal of blur caused by uniform linear motion, Wiener filtering.

Image Segmentation: Point, line and edge detection –Image segmentation based on thresholding– Region based segmentation – region growing – region splitting and merging.

MODULE– III **15**

Image Representation: Representation: chain codes – polynomial approximations – signatures – boundary descriptors – Regional descriptors.

Image Compression: Image Compression – Need for data compression – Run length encoding – Huffman coding – Arithmetic coding – predictive coding- transform based compression, Image compression standards – JPEG 2000, MPEG 4. - vector quantization – block truncation coding

TOTAL: 45

REFERENCE BOOKS

1. Gonzalez, Rafel C. and Woods, Richard E., "Digital Image Processing", Second Edition, Prentice Hall, New York, 2006.
2. Jain, Anil K., "Fundamentals of Digital Image Processing", Prentice Hall of India, New Delhi, 2003.
3. Rosenfield, Azriel and Kak, Avinash C., “Digital Picture Processing”, Academic Press Inc, New York, 1982.
4. Jayaraman. S, Esakkirajan. S, and Veerakumar. T, “Digital Image Processing” Tata McGraw-Hill, New Delhi 1st ed 2009

11CI022 REAL TIME EMBEDDED SYSTEM

3 0 0 3

Objectives:

- To get an overview of Real time systems and design and analysis
- To understand the embedded system components and its interface.
- To study in detail about embedded system design and development
- To design and develop various case studies.

MODULE - I **15**

Introduction to Real Time Systems: Definitions, classification, features, issues and challenges - Introduction to real time operating systems – timeliness, scheduling and resource management - Implementation examples with commercial VxWorks and µC/Os.

Real Time System Design and Analysis: Real time specification and design techniques-models-real time kernels- Characteristics and attributes of Real Time Kernel-kernel service-kernel implementation, performance analysis and optimization – Testing and Validation

MODULE - II **15**

Embedded System Components and its Interface: Embedded system definition- architecture and standards with examples- Embedded hardware-processors-memory devices-Interface and Peripherals-Power and its Management.

Embedded System Design and Development: Design methods and techniques – models and languages - state machine and state tables in embedded design – High level language descriptions in embedded system, Java based embedded system design – Simulation and Emulation of embedded systems- ARM processor based embedded boards- Examples with Microcontroller based embedded system development

MODULE - III **15**

Case Studies: Case studies of sector specific, time - critical and safety - critical real time embedded systems- Typical applications in automotives, communication, medicine and manufacturing- engine controls and antilock braking systems, Embedded mobile communication and positioning devices, pacemaker and patient monitoring systems, Robotics and control systems.

TOTAL: 45

REFERENCE BOOKS

1. Phillip A. Laplante, ‘Real-Time Systems Design and Analysis: An Engineer's Handbook’, Wiley Publications,2004
2. Raymond J.A.Buhr Donaid L. Balley: An introduction to real time Embedded Systems, Prentice Hall International, 1999.
3. C.M. Krishna, Kang G.Shin, Real Time Systems, McGraw Hill, 1997.
4. Herma K,Real Time systems – Design for distributed embedded applications, Kluwer academic,1997
5. Gajski D.D. Vahid, F.,Narayan S.,Specification and design of embedded systems, PTR prentice hall, 1994

11CI023 FAULT DETECTION AND DIAGNOSIS

3 0 0 3

Objective:

On completion of the course the students are expected

- To understand the concept of Fault detection methodologies
- To enhance the knowledge about redundancy concepts.

MODULE - I **15**

Introduction to Fault Detection and Diagnosis : Introduction-Scopes of fault detection and diagnosis:-Model free methods and Model based methods -Introduction to Random variables-Distribution Bivariated distribution-Multivariate distribution-Normal distribution-Maximum likelihood distribution-Hypothesis testing. Analytical redundancy concept-Additive faults and disturbance-Multiplicative faults and disturbance. Residual generation.

MODULE - II **15**

Redundancy Concepts: Detection property-Isolation property Computational of Residual generation-Specification and implementation.Parity equation implementation of residual generator-Parity equation formulation Implementation of single residual-Implementation with input output relation-Fault system matrix.

Design of Structure Residuals: Structural definition-Canonical structures-Handling disturbance-Residual structure for multiple faults.

MODULE - III **15**

Design of Directional Structured Residuals: Design for directional residual-Directional specifications-Parity equation- Residual generation for parametric faults-Representation of parametric fault-Design for parametric fault and model errors-Robustness in residual generation-Perfect decoupling from disturbance.

Data Driven Methods: Fault diagnosis using Kalman filtering-Fault diagnosis using principle component analysis -Fault diagnosis using ANN and Fuzzy clustering-Case study: Aircraft fault detection.

TOTAL: 45

REFERENCE BOOKS

1. J.Gertler, "Fault detection and diagnosis in engineering system second edition, Marcel Dekker,1998
2. Rami S.Mangoubi, "Robust Estimation and Failure detection", Springer-Verlag London, 1998
3. L.H. Chiang, E.L. Russell and R.D. Braatz, "Fault Detection and Diagnosis in Industrial Systems" – Springer-Verlag-London 2001.
4. Isermann R**., "**Fault-Diagnosis Systems An Introduction from Fault Detection to Fault Tolerance", Springer Verlag, 2006

11CI024 MULTISENSOR DATA FUSION

3 0 0 3

Objective:

- To study the basic concepts Multisensor data fusion.
- To study about the Taxonomy of algorithms for multisensor data fusion To learn the recent trends in sensor technologies
- To study about Distributed dynamic sensor fusion

MODULE - I **15**

Multisensor data fusion: Introduction, sensors and sensor data, Use of multiple sensors, Fusion applications. The inference hierarchy: output data. Data fusion model. Architectural concepts and issues. Benefits of data fusion, Mathematical tools used: Algorithms, co-ordinate transformations, rigid body motion. Dependability and Markov chains, Meta – heuristics

MODULE - II **15**

Taxonomy of algorithms for multisensor data fusion. Data association. Identity declaration. Estimation: Kalman filtering, practical aspects of Kalman filtering, extended Kalman filters. Decision level identify fusion. Knowledge based approaches.

Data information filter, extended information filter. Decentralized and scalable decentralized estimation. Sensor fusion and approximate agreement. Optimal sensor fusion using range trees recursively.

MODULE -III **15**

Distributed dynamic sensor fusion. High performance data structures: Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems with in dependability bounds. Implementing data fusion system.

TOTAL: 45

REFERENCE BOOKS

1. David L. Hall, Mathematical techniques in Multisensor data fusion, Artech House, Boston, 1992
2. R.R. Brooks and S.S. Iyengar, Multisensor Fusion: Fundamentals and Applications with Software, Prentice Hall Inc., New Jersey, 1998
3. Arthur Gelb, Applied Optimal Estimation, The M.I.T. Press, 1982.
4. James V. Candy, Signal Processing: The Model Based Approach, McGraw –Hill Book Company, 1987

11VL104 VLSI SIGNAL PROCESSING

(Common to M.E. VLSI Design, Applied Electronics, Control and Instrumentation Engineering)

3 1 0 4

Objective:

- To provide a comprehensive coverage of techniques for designing efficient DSP architectures.
- The architectural optimization both at block level as well as logic level are considered to realize architectures that can process high throughput data.
- To know the concepts of pipelined adaptive filters

MODULE – I **15**

Introduction to DSP Systems and Retiming: Introduction To DSP Systems -Typical DSP algorithms; Iteration Bound – data flow graph representations, loop bound and iteration bound, Algorithms For Computing Iteration Bound, Iteration Bound of Multirate Data Flow Graphs. Pipelining and parallel processing – Pipelining of FIR digital filters, parallel processing, pipelining and parallel processing for low power; Retiming - definitions and properties Retiming techniques; Solving systems of inequalities, Retiming Techniques.

MODULE– II **15**

Unfolding, Folding, Fast Convolution: Unfolding – an algorithm for Unfolding, properties of unfolding, Critical path Unfolding and Retiming applications of Unfolding- sample period reduction and parallel processing application; Folding – Folding transformation – Register minimizing techniques –Register minimization in folded architectures-Folding of Multirate systems. Fast convolution – Cook-Toom algorithm, modified Cook-Took algorithm – Wino grad Algorithm, Modified Wino grad Algorithm, Iterated Convolution – Cyclic Convolution-Design of Fast Convolution algorithm by inspection.;

MODULE-III **15**

Pipelined and Parallel Recursive and Adaptive Filters: Algorithmic strength reduction in Filters-Parallel FIR Filters, DCT and Inverse DCT, Parallel architectures for rank order Filters. Pipelined and parallel recursive and adaptive filters – inefficient/efficient single channel interleaving, Look- Ahead pipelining in first- order IIR filters, Look-Ahead pipelining with power-of-two decomposition parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters, pipelined adaptive digital filters-relaxed look-ahead, pipelined LMS adaptive filter.

Lecture: 45, Tutorial: 15, TOTAL : 60

REFERENCE BOOKS

1. Parhi, Keshab K., "VLSI Digital Signal Processing Systems, Design and Implementation", John Wiley, Inter Science, New York, 1999.
2. Isamail, Mohammed and Fiez, Terri, "Analog VLSI Signal and Information Processing", McGraw-Hill, New York, 1994**.**
3. www.pdf-search-engine.com/vlsi-signal-processing-pdf.html
4. Magdy A. Bayoumi, Magdy A. Bayoumi, E. Swartzlander, "VLSI Signal Processing Technology", Kluwer Academic Publishers.October 1994
5. Ray Liu K J, "High Performance VLSI Signal Processing, Innovative architectures and Algorithms",IEEE Press,1998