AFFILIATED INSTITUTIONS

ANNA UNIVERSITY, CHENNAI

REGULATION - 2013

M.E. INSTRUMENTATION ENGINEERING

I TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS

SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	IN7101	Industrial Data Networks	3	0	0	3
2.	IN7102	Linear and Non-Linear Systems Theory	3	0	0	3
3.	IN7103	Process Control	3	0	0	3
4.	IN7104	Transducers and Smart Instruments	3	0	0	3
5.	IN7105	Advanced Digital Signal Processing and its Applications	3	0	0	3
6.	MA7169	Advanced Numerical Methods	3	1	0	4
PRACTICAL						
7.	IN7111	Process Control and Instrumentation Laboratory	0	0	3	2
		TOTAL	**18**	**1**	**3**	**21**

SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	IN7201	Advanced Process Control	3	0	0	3
2.	IN7202	Instrumentation System Design	3	0	2	4
3.	CL7001	Applied Industrial Instrumentation	3	0	0	3
4.		Elective - I	3	0	0	3
5.		Elective - II	3	0	0	3
6.		Elective - III	3	0	0	3
		TOTAL	**18**	**0**	**2**	**19**

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.		Elective - IV	3	0	0	3
2.		Elective - V	3	0	0	3
3.		Elective - VI	3	0	0	3
PRACTICAL						
4.	IN7311	Project Work Phase - I	0	0	12	6
		TOTAL	**9**	**0**	**12**	**15**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1.	IN7411	Project Work Phase II	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

TOTAL NUMBER OF CREDITS 67

ELECTIVES FOR M.E INSTRUMENTATION ENGINEERING
SEMESTER II

ELECTIVE - I						
SL. NO	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1.	CL7008	Fault Tolerant Control	3	0	0	3
2.	IN7001	Adaptive Control	3	0	0	3
3.	IN7002	Advanced Image Processing	3	0	0	3

ELECTIVE - II						
SL.NO	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
4.	IN7003	Advanced Operating System Principles	3	0	0	3
5.	IN7004	Applied Biomedical Instrumentation	3	0	0	3
6.	IN7005	Applied Soft Computing	3	0	0	3

ELECTIVE - III						
SL. NO	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
7.	IN7006	Biomedical Signal Processing	3	0	0	3
8.	IN7007	Embedded Systems Architecture	3	0	0	3
9.	IN7008	Industrial Drives and Control	3	0	0	3

SEMESTER III

ELECTIVE - IV						
SL.NO	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	IN7009	Instrumentation in Petrochemical Industry	3	0	0	3
2	IN7010	Optimal Control	3	0	0	3
3	IN7011	Optimal State Estimation	3	0	0	3

ELECTIVE - V						
SL. NO	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
4	IN7012	Robotics and Automation	3	0	0	3
5	IN7013	System Identification	3	0	0	3
6	IN7014	Thermal Power Plant Instrumentation	3	0	0	3

ELECTIVE - VI						
SL. NO	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
7	IN7015	Virtual Instrumentation	3	0	0	3
8	IN7016	VLSI System Design	3	0	0	3
9	CL7003	Wireless Sensor Networks	3	0	0	3
10	CL7002	Robust Control	3	0	0	3
11	ET7010	Cryptography and Network Security	3	0	0	3

IN7101	INDUSTRIAL DATA NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To give an overview of the Industrial data communications systems
- To provide a fundamental understanding of common principles, various standards, protocols
- To provide in
- sight into some of the new principles those are evolving for future networks.

COURSE OUTCOMES

- Ability to develop an understanding of and be able to select and use most appropriate technologies and standards for a given application
- Ability to design and ensuring that best practice is followed in installing and commissioning the data communications links to ensure they run fault-free

UNIT I DATA NETWORK FUNDAMENTALS **9**

EIA 232 interface standard – EIA 485 interface standard – EIA 422 interface standard – Serial interface converters - ISO/OSI Reference model – Data link control protocol – Media access protocol:-Command/response, Token passing and CSMA/CD - TCP/IP – Bridges – Routers – Gateways –Standard ETHERNET Configuration

UNIT II PLC, PLC PROGRAMMING & SCADA **9**

Evolutions of PLCs – Programmable Controllers – Architecture – Comparative study of Industrial PLCs. –PLC Programming:- Ladder logic, Functional block programming, Sequential function chart, Instruction list and Structured text programming. SCADA:- Remote terminal units, Master station, Communication architectures and Open SCADA protocols.

UNIT III DISTRIBUTED CONTROL SYSTEM & HART **9**

Evolution - Different architectures - Local control unit - Operator Interface – Displays - Engineering interface - Study of any one DCS available in market - Factors to be considered in selecting DCS – Case studies in DCS. Introduction- Evolution of signal standard – HART communication protocol – Communication modes – HART Networks – HART commands – HART applications – MODBUS protocol structure – Function codes – Troubleshooting

UNIT IV PROFIBUS AND FF **9**

Fieldbus:- Introduction, General Fieldbus architecture, Basic requirements of Fieldbus standard, Fieldbus topology, Interoperability and Interchangeability Profibus:- Introduction, Profibus protocol stack, Profibus communication model, Communication objects, System operation and Troubleshooting – Foundation fieldbus versus Profibus.

UNIT V AS – INTERFACE (AS-i), DEVICENET AND INDUSTRIAL ETHERNET **9**

AS interface:- Introduction, Physical layer, Data link layer and Operating characteristics.
Devicenet:- Introduction, Physical layer, Data link layer and Application layer. Industrial Ethernet:- Introduction, 10Mbps Ethernet and 100Mbps Ethernet - Introduction to OLE for process control

TOTAL 45 PERIODS

REFERENCE BOOKS

1. T.A. Hughes, "Programmable Logic Controllers: Resources for Measurements and Control Series", Third edition, ISA Press, 2000.
2. R.Bowden, "HART Application Guide", HART Communication Foundation, 1999.
3. G.K.McMillan, "Process/Industrial Instrument and Controls Handbook", Fifth Edition, McGraw-Hill handbook, New York, 1999.
4. J.Berge, "Field Buses for Process Control: Engineering, Operation, and Maintenance", ISA Press, 2004.
5. S.Mackay, E.Wright, D.Reynders, and J.Park, "Practical Industrial Data Networks: Design, Installation and Troubleshooting", Newnes Publication, Elsevier, 2004.
6. W.Buchanan, "Computer Busses: Design and Application", CRC Press, 2000.
7. F.D.Petruzella, "Programmable Logic Controllers", Third Edition, Tata McGraw-Hill, 2010.
8. M.P.Lucas, "Distributed Control System", Van Nostrand Reinhold Company, New York, 1986.
9. G.Clarke, D.Reynders and E.Wright, "Practical Modern SCADA Protocols: DNP3, IEC 60870.5 and Related Systems", Newnes, First Edition, 2004.

IN7102	LINEAR AND NON-LINEAR SYSTEMS THEORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To develop the skills needed to represent the system in state space form
- To impart knowledge required to design state feedback controller and state observers
- To impart knowledge and skills needed to classify singular points and construct phase trajectory using delta and isocline methods.
- To make the students understand the concepts of stability and introduce techniques to assess the stability of certain class of non-linear system using describing function, Lyapunov Stability, Popov's Stability Criterion and Circle Criterion
- To make the students understand the various non-linear behaviors such as Limit cycles, input multiplicity and output multiplicity, Bifurcation and Chaos.

COURSE OUTCOMES

- Ability to represent the time-invariant systems in state space form as well as analyze,
- whether the system is stabilizable, controllable, observable and detectable.
- Ability to design state feedback controller and state observers
- Ability to classify singular points and construct phase trajectory using delta and isocline methods.
- Use the techniques such as describing function, Lyapunov Stability, Popov's Stability Criterion and Circle Criterion to assess the stability of certain class of non-linear system.
- Ability to describe non-linear behaviors such as Limit cycles, input multiplicity and output multiplicity, Bifurcation and Chaos.

9

UNIT I STATE SPACE APPROACH

Review of state model for systems – No uniqueness of state model - Role of Eigen values and Eigenvectors - State transition matrix and its properties – free and forced responses – State Diagrams - minimal realization – balanced realization.

UNIT II STATE FEEDBACK CONTROL AND STATE ESTIMATOR 9

Controllability and observability – Stabilizability and Detectability - Kalman Decomposition - State Feedback – Pole placement technique – Full order and Reduced Order Observers

UNIT III NON-LINEAR SYSTEMS 9

Types of Non-Linearity – Typical Examples – Singular Points - Phase plane analysis (analytical and graphical methods) – Limit cycles – Equivalent Linearization – Describing Function Analysis, Derivation of Describing Functions for different non-linear elements.

UNIT IV STABILITY OF NON-LINEAR SYSTEMS 9

Stability concepts – Equilibrium points – BIBO and Asymptotic stability – Stability Analysis by DF method – Lyapunov Stability Criteria – Krasovskil's method – Variable Gradient Method – Popov's Stability Criterion – Circle Criterion

UNIT V NON-LINEAR SYSTEMS ANALYSIS 9

Bifurcation Behavior of Single ODE Systems: - Motivation, Illustration of Bifurcation Behavior and Types of Bifurcations - Bifurcation Behavior of Two-State Systems: - Dimensional Bifurcations in the Phase-Plane, Limit Cycle Behavior and Hopf Bifurcation - Introduction to Chaos: The Lorenz Equations, Stability Analysis of the Lorenz Equations, Numerical Study of the Lorenz Equations, Chaos in Chemical Systems and Other Issues in Chaos

TOTAL 45 PERIODS

REFERENCE BOOKS

1 K.Ogata, "Modern Control Engineering", Prentice Hall, Fifth Edition, 2010.

2 M.Gopal, "Digital Control and State Variable Methods: Conventional and Intelligent Control Systems", Third Edition, Tata Mc-Graw Hill, 2009.

3 B.W.Bequette, "Process Control: Modeling, Design and Simulation", Prentice Hall International series in Physical and Chemical Engineering Sciences, 2003.

4 Steven E. LeBlanc, Donald R. Coughanowr, "Process Systems Analysis and Control", Third Edition, Chemical Engineering series, McGraw-Hill Higher Education, 2008

IN7103	PROCESS CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To give an overview of the features associated with Industrial Type PID Controller such as reset windup, bumpless auto-manual transfer, proportional kick and derivative kick.
- To make the students understand the various PID tuning methods
- To elaborate different types of control schemes such as cascade control, feed-forward control, DMC, GPC, Inferential control schemes, Multi-variable control schemes etc.

COURSE OUTCOMES

- Ability to Apply knowledge of mathematics, science, and engineering to the build and analyze models for flow, level, and thermal processes
- Ability to determine the advanced Features supported by the Industrial Type PID Controller.
- Ability to Design, tune and implement SISO P/PI/PID Controllers to achieve desired Performance for various processes
- Ability to Analyze Multivariable Systems and Design Multi-variable and Multi-loop Control Schemes for various processes namely four-tank system, pH process, bio-reactor, distillation column
- Ability to Identify, formulate, and solve problems in the process control domain

UNIT I PROCESS DYNAMICS & CONTROL ACTIONS 9

Need for process control – Hierarchical decomposition of Control Functions - Continuous and batch processes – P&ID diagram - Self regulation - Interacting and non-interacting systems - Mathematical model of Level, Flow and Thermal processes – Lumped and Distributed parameter models – Linearization of nonlinear systems - Characteristic of ON-OFF, P, P+I, P+D and P+I+D control modes – Digital PID algorithm – Auto/manual transfer - Reset windup – Practical forms of PID Controller

UNIT II PID CONTROLLER TUNING – SINGLE LOOP REGULATORY CONTROL 9

Evaluation criteria – IAE, ISE, ITAE and ¼ decay ratio – Tuning :- Process reaction curve method:- Z-N and Cohen-Coon methods, Continuous cycling method and Damped oscillation method – optimization methods – Auto tuning.

UNIT III ENHANCEMENT TO SINGLE LOOP REGULATORY CONTROL & MODEL BASED CONTROL SCHEMES 9

Cascade control – Split-range - Feed-forward control – Ratio control – Inferential control –– override control - Smith predictor control scheme - Internal Model Controller - IMC PID controller – Single Loop Dynamic Matrix Control – Generalized Predictive Control

UNIT IV MULTIVARIABLE SYSTEMS & MULTI-LOOP REGULATORY CONTROL 9

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

UNIT V MULTIVARIABLE REGULATORY CONTROL & CASE –STUDIES **9**

Introduction to Multivariable control – Multivariable PID Controller -Multivariable IMC – Multivariable Dynamic Matrix Controller - Multiple Model based Predictive Controller –Predictive PID Control - Control Schemes for Distillation Column, CSTR, Bioreactor, Four-tank system, pH, and polymerization reactor.

TOTAL 45 PERIODS

REFERENCE BOOKS

1 B.Wayne Bequette, "Process Control: Modeling, Design, and Simulation", Prentice Hall of India, 2004.

2 Dale E. Seborg , Duncan A. Mellichamp , Thomas F. Edgar, and Francis J. Doyle, III "Process Dynamics and Control", John Wiley and Sons, 3rd Edition, 2010.

3 Jose A. Romagnoli and Ahmet Palazoglu , "Introduction to Process Control", CRC Press, Taylor and Francis Group, Second Edition, First Indian Reprint, 2010.

4 Coleman Brosilow and Babu Joseph, "Techniques of Model-based Control", Prentice Hall International Series, PTR, New Jersey, 2001.

IN7104	TRANSDUCERS AND SMART INSTRUMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To give a detailed knowledge on transducer characteristics and uncertainties in measurement
- To provide a detailed knowledge on error and determination of uncertainties in measurement.
- To give a comprehensive knowledge on smart sensor Design , Development and Challenges.
- To give exposure to manufacturing techniques and different types of Micro sensors and actuators
- To give an overview of latest advancement and trend in transducer systems.

COURSE OUTCOMES

Students'

- Will be able to completely characterize a conventional transducer.
- Can confidently analyze and quantify the uncertainties in measurement data.
- Will have the capability to design and develop customized smart sensors.
- Acquire a comprehensive Knowledge of manufacturing techniques and design aspects of micro sensors and actuators
- Get exposure to latest sensor technology and advanced measurement Methodologies.

9

UNIT I OVERVIEW OF CONVENTIONAL TRANSDUCERS AND ITS CHARACTERISTICS

Overview of conventional sensors - Resistive, Capacitive, Inductive, Piezoelectric, Magnetostrictive and Hall effect sensors - Static and Dynamic Characteristics and specifications.

UNIT II MEASUREMENT ERROR AND UNCERTAINTY ANALYSIS 9

Importance of error analysis - Uncertainties, precision and accuracy in measurement - Random errors - Distributions, mean, width and standard error - Uncertainty as probability - Gaussian and Poisson probability distribution functions, confidence limits, error bars, and central limit theorem - Error propagation - single and multi-variable functions, propagating error in functions - Data visualization and reduction - Least square fitting of complex functions

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UNIT III SMART SENSORS 9

Definition – Integrated smart sensors - Interface electronics - Design, sensing elements and parasitic effects, ADC, Accuracy and Dynamic range - Universal Sensor Interface – converters - front end circuits DAQ – Design - Digital conversion techniques - Microcontrollers and digital signal processors for smart sensors – selection - Timer, Analog comparator, ADC and DAC modules - Standards for smart sensor interface.

UNIT IV MICRO SENSORS AND ACTUATORS 9

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- Introduction to Nano sensors.

UNIT V RECENT TRENDS IN SENSOR TECHNOLOGIES 9

Thick film and thin film sensors- Electro chemical sensors – RFIDs - Sensor arrays - Sensor network - Multisensor data fusion - Soft sensor.

TOTAL 45 PERIODS

REFERENCE BOOKS

1 Ernest O Doebelin and Dhanesh N Manik, “Measurement Systems Application and Design”, 5thEdition, Tata Mc-Graw Hill, 2009.

2 Ifan G. Hughes and Thomas P.A. Hase, Measurements and their Uncertainties: A Practical Guide to Modern Error Analysis, Oxford University Press, 2010.

3 Gerord C.M. Meijer, Smart Sensor Systems, John Wiley and Sons, 2008.

4 Tai-Ran Hsu, Mems and Micro Systems: Design and Manufacture, Tata McGraw Hill, 2002.

5 D. Patranabis, “Sensors and Transducers”, Second Edition, PHI, 2004.

IN7105	ADVANCED DIGITAL SIGNAL PROCESSSING AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To give an overview of Advanced Digital Signal Processing subject with conceptual clarity.
- To provide the foundation for signal modeling, linear prediction and estimation theory.
- To impart knowledge on adaptive filter design, multi-rate signal processing and filter banks.

COURSE OUTCOMES

- Ability to apply the knowledge of mathematics, science, and engineering for the analysis and design of digital systems.
- Ability to identify, formulate and solve engineering problems in the area of random signal processing and spectrum estimation.
- Ability to design adaptive filters with realistic constraints.

UNIT I REVIEW OF DIGITAL SIGNALS, SYSTEMS AND FILTERS 9

Discrete Time Fourier Transform – Frequency response of LTI systems - Discrete Fourier Transform - Fast Fourier Transform algorithms: Decimation in time and decimation in frequency algorithm - Digital filters: FIR filter, IIR filter.

UNIT II RANDOM SIGNAL PROCESSING AND SPECTRUM ESTIMATION 9

Discrete random processes - Expectation, Variance, Parseval's Theorem, Wiener Khintchine Relation - Power spectral density - Periodogram – Sample autocorrelation - Sum decomposition theorem, Spectral factorization theorem - Non-parametric methods - Correlation method - Co-variance estimator - Consistent estimators -Periodogram estimator - Barlett spectrum estimation - Welch estimation - Model based approach - AR, MA, ARMA signal modeling - Parameter estimation using Yule-Walker method.

UNIT III LINEAR ESTIMATION AND PREDICTION 9

Maximum likelihood criterion - efficiency of estimator - Least mean squared error criterion - Wiener filter - Discrete Wiener Hoff equations - Recursive estimators - Kalman filter - Linear prediction, prediction error - whitening filter, inverse filter - Levinson recursion, Lattice realization, and Levinson recursion algorithm for solving Toeplitz system of equations.

UNIT IV ADAPTIVE FILTERS 9

FIR adaptive filters - Newton's steepest descent method - Adaptive filter based on steepest descent method - Widrow Hoff LMS adaptive algorithm - Adaptive channel equalization - Adaptive echo chancellor - Adaptive noise cancellation - RLS adaptive filters - Exponentially weighted RLS - Sliding window RLS - Simplified IIR LMS adaptive filter.

UNIT V MULTIRATE DIGITAL SIGNAL PROCESSING 9

Mathematical description of change of sampling rate - Interpolation and Decimation - continuous time model - Direct digital domain approach - Decimation by an integer factor - Interpolation by an integer factor - Single and multistage realization - poly phase realization - Application to sub band coding - Wavelet transform and filter bank implementation of wavelet expansion of signals.

TOTAL 45 PERIODS

REFERENCE BOOKS

1. J.G.Proakis and D.G.Manolakis, " Digital Signal Processing: Principles, Algorithms and Applications ", 4th Edition, Pearson Prentice-Hall of India, 2007.
2. Monson H.Hayes, "Statistical Digital Signal Processing and Modeling ", Wiley India, 2008.
3. P. P. Vaidyanathan, “Multirate Systems and Filter Banks”, Prentice Hall Signal Processing Series, Pearson, 2004.
4. Tulay Adali and Simon Haykin, “Adaptive Signal Processing, Next Generation Solutions”, John Wiley and Sons, 2010.
5. Ali Ahammad Shoukat Choudhury, Sirish L. Shah and Nina F.Thornhill, “Diagnosis of Process Nonlinearities and Valve Stiction: Data Driven Approaches”, Springer, 2008.

MA7169 ADVANCED NUMERICAL METHODS L T P C
3 1 0 4

OBJECTIVES:

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

UNIT I ALGEBRAIC EQUATIONS (9+3)

Systems of linear equations: Gauss Elimination method, pivoting techniques, Thomas algorithm for tridiagonal system – Jacobi, Gauss Seidel, SOR iteration methods - Systems of nonlinear equations: Fixed point iterations, Newton Method, Eigenvalue problems: power method, inverse power method, Faddeev – Leverrier Method.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS (9+3)

Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

UNIT III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION (9+3)

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines – Wave equation: Explicit scheme-Stability of above schemes.

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS (9+3)

Laplace and Poisson’s equations in a rectangular region: Five point finite difference schemes, Leibmann’s iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes – approximation of derivatives near a curved boundary while using a square mesh.

UNIT V FINITE ELEMENT METHOD (9+3)

Partial differential equations – Finite element method - orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

TOTAL : 60 PERIODS

OUTCOME:

It helps the students to get familiarized with the numerical methods which are necessary to solve numerically the problems that arise in engineering.

REFERENCES

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Gupta S.K., "Numerical Methods for Engineers", New Age Publishers, 1995
3. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", Cengage Learning, India Edition, New Delhi, 2009.
4. Jain M. K., Iyengar S. R., Kanchi M. B., Jain , "Computational Methods for Partial Differential Equations", New Age Publishers,1993.
5. Morton K.W. and Mayers D.F., "Numerical solution of partial differential equations", Cambridge University press, Cambridge, 2002.

IN7111 PROCESS CONTROL AND INSTRUMENTATION LABORATORY

L	T	P	C
0	0	3	2

1. (a) Study of Process Control Training plant

   (b) Piping and Instrumentation diagram

2. Simulation of lumped parameter and Distributed parameter systems.
3. Identification of linear dynamic model of a process using non- parametric methods.
4. (a) Design and implementation PID Control scheme on the simulated process.

   (b) PID Implementation issues

5. Level and pressure control (with and without Interaction) in process control Test Rig.
6. Auto- Tuning of PID controller
7. Design and implementation of Feed forward and Cascade control schemes on the simulated model of CSTR process.
8. (a) Analysis of MIMO system.

   (b) Design and implementation of Multi-loop PID and Multivariable PID control schemes on the simulated model of two-tank systems.

9. Design and implementation of Robust PID control schemes on the simulated

   model of variable area tank process.

10. a) Design and implementation of Self-tuning and Model Reference Adaptive Control schemes on the simulated model of variable area tank process.

    (b) Design and implementation of gain scheduled Adaptive controller on the

    simulated model of variable area tank process.

11. Study of MPC toolbox.

12 a) On-line Monitoring and Control Using Distributed Control System

   b) Implementation of Discrete Control Sequence using Programmable Logic Controller.

TOTAL 45 PERIODS

IN7201	ADVANCED PROCESS CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To teach students to build and analyze models for time-varying systems and non-linear systems.
- To develop the skills needed to design adaptive controllers such as gain-scheduled adaptive controller, Model-reference adaptive controller and Self-tuning controller for various applications
- To make the students learn to formulate optimal control schemes
- To provide basic knowledge about Fractional-order systems and Fractional-order-controller and to lay the foundation for the systematic approach to Design controller for fractional order systems
- To introduce FDI Techniques, such as Principal component Analysis, state observer to detect and diagnose faults in sensors and actuators

COURSE OUTCOMES

- Ability to Apply knowledge of mathematics, science, and engineering to build and analyze models for time-varying systems and non-linear systems.
- Ability to design and implement adaptive controllers such as gain-scheduled adaptive controller, Model-reference adaptive controller and Self-tuning controller
- Ability to Identify, formulate, and solve optimal controller
- Ability to Analyze Fractional-order systems, Fractional-order- controller and Design controller for fractional order systems
- Ability to design and implement H_2 and H-infinity Controllers
- Ability to use the FDI Techniques, such as Principal component Analysis, state observer to detect and diagnose faults in sensors and actuators

UNIT I CONTROL OF TIME-VARYING AND NONLINEAR SYSTEMS 9

Models for Time-varying and Nonlinear systems – Input signal design for Identification –Real-time parameter estimation – Model Validation - Types of Adaptive Control - Gain scheduling - Adaptive Control - Deterministic Self-tuning Controller and Model Reference Adaptive Controller – Control of Hammerstein and Wiener Systems

UNIT II OPTIMAL CONTROL & FILTERING 9

Introduction – Performance Measure for optimal control problem – Dynamic Programming – Computational Procedure for solving Control Problem – LQR – Introduction to Optimal Filtering – Discrete Kalman Filter – LQG

UNIT III FRACTIONAL ORDER SYSTEM & CONTROLLER 9

Fractional-order Calculus and Its Computations – Frequency and Time Domain Analysis of Fractional-Order Linear Systems - Filter Approximations to Fractional-Order Differentiations – Model reduction Techniques for Fractional Order Systems –Controller Design Studies for Fractional Order

UNIT IV H-INFINITY CONTROLLER 9

Introduction – Norms for Signals – Robust Stability – Robust Performance – Small Gain Theorem – Optimal H_2 Controller Design - H-Infinity Controller Design –– Effects of Weighting Functions in H-Infinity Control.

UNIT V FAULT DIAGNOSIS AND FAULT-TOLERANT CONTROL **9**

Process Monitoring - Introduction – Statistical Process Control – Fault Detection with Principal Component Analysis – Fault Detection with State Observers – Fault Detection with signal models - Fault Detection of Control Loops- Sensor and Actuator Fault-Tolerant Control Design

TOTAL 45 PERIODS

REFERENCE BOOKS

1 K.J. Astrom and B.J.Wittenmark, “Adaptive Control”, Pearson Education, Second Edition, 2008.

2 Donald E.Kirk, "Optimal Control Theory – An Introduction", Dover Publications, Inc. Mineola, New York, 2004

3 D.Xue, Y.Q.Chen, D.P.Atherton, "Linear Feedback Control Analysis and Design with MATLAB, Advances In Design and Control", Society for Industrial and Applied Mathematics, 2007.

4 R. Isermann, "Fault-Diagnosis Systems: An Introduction from Fault Detection to Fault Tolerance", Springer, 2005

IN7202	**INSTRUMENTATION SYSTEM DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

COURSE OBJECTIVES

- To impart knowledge on the design of signal conditioning circuits for the measurement of Level, temperature and pH.
- To develop the skills needed to design, fabricate and test Analog/ Digital PID controller, Data Loggers and Alarm Annunciator
- To make the students familiarize design orifice and control valve sizing.

COURSE OUTCOMES

- Ability to design signal conditioning circuits for temperature sensors, V/I and I/V converters
- Ability to design and fabricate smart transmitters
- Ability to design, fabricate and test PID controllers and alarm circuits
- Ability to carryout orifice and control valve sizing for Liquid/Steam Services

UNIT I DESIGN OF SIGNAL CONDITIONING CIRCUITS **9**

Design of V/I Converter and I/V Converter- Analog and Digital filter design and Adaptive filter design – Signal conditioning circuit for pH measurement, Air-purge Level Measurement – Signal conditioning circuit for Temperature measurement: Thermocouple, RTD and Thermistor - Cold Junction Compensation and Linearization – software and Hardware approaches

UNIT II DESIGN OF TRANSMITTERS **9**

Study of 2 wire and 4 wire transmitters – Design of RTD based Temperature Transmitter, Thermocouple based Temperature Transmitter, Capacitance based Level Transmitter and Smart Flow Transmitters.

UNIT III DESIGN OF DATA LOGGER AND PID CONTROLLER **9**

Design of ON / OFF Controller using Linear Integrated Circuits - Electronic PID Controller – Microcontroller Based Digital Two-degree of freedom PID Controller - Micro - controller based Data Logger – Design of PC based Data Acquisition Cards

UNIT IV ORIFICE AND CONTROL VALVE SIZING **9**

Orifice, Venturi and flow nozzle Sizing: - Liquid, Gas and steam services – Control valve sizing – Liquid, Gas and steam Services – Rotameter Design.

UNIT V DESIGN OF ALARM AND ANNUNCIATION CIRCUIT **9**

Alarm and Annunciation circuits using Analog and Digital Circuits – Design of Programmable Logic Controller - Design of configurable sequential controller using PLDs

TOTAL 45 PERIODS

Practical Component

1. Design Fabrication and Testing of 2 wire / 4 wire analog transmitters 5 Hrs
2. Design, Fabrication and Testing of Data Logger
3. Design Fabrication and Testing of PID Controllers (Analog / Digital) 5 Hrs
4. Design Fabrication and Testing of Alarm Annunciation Circuits 5 Hrs
5. Development of Software Package for sizing Orifice/ Control valve / Rotameter 5 Hrs
6. Design of Programming Logic Controller using Microcontroller 5 Hrs

TOTAL 30 PERIODS

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 R.W. Miller, "Flow Measurement Engineering Handbook", Mc-Graw Hill, New York 1996.

4 Bela G. Liptak, "Instrument Engineers Handbook - Process Control and Optimization", 4th Edition, Vol.2, CRC Press.

CL7001 APPLIED INDUSTRIAL INSTRUMENTATION **L T P C**
3 0 0 3

OBJECTIVES

- To enable students acquire knowledge about the various techniques used for the measurement of primary industrial parameters like flow, level, temperature and pressure.
- To understand the important parameters to be monitored and analyzed in Thermal power Plant
- To get an exposure on the important parameters to be monitored and analyzed in Petrochemical Industry
- To learn about the hazardous zone classification and intrinsic safety techniques to the adapted in industries.
- Learn about other special purpose instruments like Nuclear radiation detection
- techniques, fibre optic sensors, Instrumentation for NDT applications etc

UNIT I REVIEW OF INDUSTRIAL INSTRUMENTATION **9**

Overview of Measurement of Flow, level, Temperature and Pressure.

UNIT II MEASUREMENT IN THERMAL POWER PLANT (BOILERS) **9**

Selection and Installation of instruments used for the Measurement of fuel flow, Air flow, Drum level, Steam pressure, Steam temperature – Feed water quality measurement- Flue gas Oxygen Analyzers- Coal Analyzer.

UNIT III MEASUREMENT IN PETROLEUM REFINERY **9**

Parameters to be measured in petroleum industry:-Flow, Level, Temperature and Pressure measurement in Distillation, Pyrolysis, catalytic cracking and reforming process-Hydrocarbon analyzers-oil in or on water- sulphur in oil Analyzer.

UNIT IV INSTRUMENTATION FOR INDUSTRIAL SAFETY **9**

Electrical and Intrinsic Safety - Explosion Suppression and Deluge systems –Conservation and emergency vents - Flame, fire and smoke detectors - Leak Detectors - Metal Detectors.

UNIT V SPECIAL PURPOSE INSTRUMENTATION **9**

Detection of Nuclear Radiation – Corrosion monitoring – Fibre optic sensors-Instrumentation in weather stations – Instrumentation for NDT applications-Image processing Technique for measurements.

TOTAL : 45 PERIODS

REFERENCES

1. B.G.Liptak, “Instrumentation Engineers Handbook (Process Measurement & Analysis)”, Fourth Edition, Chilton Book Co, 2003.
2. K.Krishnaswamy and M.Ponnibala, “Power Plant Instrumentation”, PHI Learning Pvt Ltd, 2011.
3. John G Webster, “The Measurement, Instrumentation, and Sensors Handbook”, CRC and IEEE Press, 1999.
4. Håvard Devold, “Oil and Gas Production Handbook - An Introduction to Oil and Gas Production”, ABB ATPA oil and gas, 2006.
5. M.Arumugam, “Optical Fibre Communication and Sensors”, Anuradha Agencies, 2002.
6. Paul E. Mix, “Introduction to Nondestructive Testing”, John Wiley and Sons, 2005.

CL7008 FAULT TOLERANT CONTROL **L T P C**
3 0 0 3

OBJECTIVES

- To give an overview of different Fault Detection and Diagnosis methods
- To impart knowledge and skills needed to design and detect sensor and actuators faults using structured residual approach as well as directional structured residual approach
- To impart knowledge and skills needed design and detect faults in sensor and actuators using GLR and MLR based Approaches
- To present an overview of various types of fault tolerant control schemes such as Passive and active approaches
- To impart knowledge and skills needed to detect and quantify and compensate stiction in Control valves

COURSE OUTCOMES

- Ability to Explain different approaches to Fault Detection and Diagnosis
- Ability to design and detect sensor and actuators faults using structured residual approach as well as directional structured residual approach
- Ability to design and detect faults in sensor and actuators using GLR and MLR based Approaches
- Ability to explain various types of fault tolerant control schemes such as Passive and active approaches
- Ability to Design fault-tolerant control scheme in the presence of actuator failures
  Ability to detect and quantify and compensate stiction in Control valves

UNIT I INTRODUCTION & ANALYTICAL REDUNDANCY CONCEPTS 9

Introduction - Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches-Introduction-Mathematical representation of Faults and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation

UNIT II DESIGN OF STRUCTURED RESIDUALS & DIRECTIONAL STRUCTURED RESIDUALS **9**

Introduction- Residual structure of single fault Isolation: Structural and Canonical structures- Residual structure of multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation - Directional Specifications: Directional specification with and without disturbances – Parity Equation Implementation

UNIT III FAULT DIAGNOSIS USING STATE ESTIMATORS **9**

Introduction – State Observer – State Estimators – Norms based residual evaluation and threshold computation - Statistical methods based residual evaluation and threshold settings: Generalized Likelihood Ratio Approach – Marginalized Likelihood Ratio Approach

UNIT IV FAULT TOLERANT CONTROL **9**

Introduction – Passive Fault-tolerant Control- Active Fault tolerant Control - Actuator and Sensor Fault tolerance Principles:- Compensation for actuator – Sensor Fault-tolerant Control Design – Fault-tolerant Control Architecture - Fault-tolerant Control design against major actuator failures.

UNIT V CASE STUDIES 9

Fault tolerant Control of Three-tank System – Diagnosis and Fault-tolerant control of chemical process – supervision of steam generator – Different types of faults in Control valves – Automatic detection, quantification and compensation of valve stiction

TOTAL: 45PERIODS

REFERENCE BOOKS

1. Janos J. Gertler, "Fault Detection and Diagnosis in Engineering systems" –2nd Edition, Marcel Dekker, 1998.
2. Rolf Isermann, Fault-Diagnosis Systems an Introduction from Fault Detection to Fault Tolerance, Springer Verlag, 2006.
3. Steven X. Ding, Model based Fault Diagnosis Techniques: Schemes, Algorithms, and Tools, Springer Publication, 2008.
4. Hassan Noura, Didier Theilliol, Jean-Christophe Ponsart, Abbas Chamseddine, Fault-Tolerant Control Systems: Design and Practical Applications, Springer Publication, 2009.
5. Mogens Blanke, Diagnosis and Fault-Tolerant Control, Springer, 2003.
6. Ali Ahammad Shoukat Choudhury, Sirish L. Shah, Nina F. Thornhill, Diagnosis of Process Nonlinearities and Valve Stiction: Data Driven Approaches, Springer, 2008.

IN7001 **ADAPTIVE CONTROL** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To impart knowledge on how to recursively estimate the parameters of discrete input – output models (ARX/ARMAX etc) using recursive parameter estimation methods
- To make the student understand the principles of STR, MRAC and Gain scheduling.
- To make the student design simple adaptive controllers for linear systems using above methods

COURSE OUTCOMES

- Will be able to design simple adaptive controllers for linear systems.
- Ability to identify, formulate, analyse the implementation of adaptive controllers t engineering problems.

UNIT I INTRODUCTION **9**

Introduction - Adaptive Schemes - The adaptive Control Problem – Applications - Real-time parameter estimation: - Least squares and regression methods- Estimating parameters in dynamical systems

UNIT II GAIN SCHEDULING **9**

Introduction- The principle - Design of gain scheduling controllers- Nonlinear transformations - application of gain scheduling - Auto-tuning techniques: Methods based on Relay feedback

UNIT III DETERMINISTIC SELF-TUNING REGULATORS **9**

Introduction- Pole Placement design - Indirect Self-tuning regulators - direct self-tuning regulators – Disturbances with known characteristics

UNIT IV STOCHASTIC AND PREDICTIVE SELF-TUNING REGULATORS **9**

Introduction – Design of minimum variance controller - Design of moving average controller - stochastic self-tuning regulators

UNIT V MODEL – REFERENCE ADAPTIVE SYSTEM ATIONS **9**

Introduction- MIT rule – Determination of adaptation gain - Lyapunov theory –Design of MRAS using Lyapunov theory – Relations between MRAS and STR.

TOTAL 45 PERIODS

REFERENCE BOOKS

1 K.J. Astrom and B. J. Wittenmark, “Adaptive Control”, Second Edition, Pearson Education Inc., 1995.

2 T. Soderstorm and Petre Stoica, “System Identification”, Prentice Hall International(UK) Ltd., 1989.

3 N.Mathivanan, ”PC-based Instrumentation Concepts and Practice”, Eastern Economy Edition, PHI Learning private ltd ,2009

4 Lennart Ljung, “System Identification: Theory for the User”, Second Edition, Prentice Hall, 1999.

IN7002	ADVANCED IMAGE PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the image fundamentals and transforms
- To impart knowledge in image enhancement
- To give exposure to image restoration and image compression
- To familiarize the students on image analysis
- To make the students to understand the concept of pattern recognition

COURSE OUTCOMES

- Be able to apply image enhancement, image compression, restoration techniques, image segmentation approaches.
- Ability to apply image processing techniques in both the spatial and frequency domains.
- Be capable of applying image processing algorithms to real problems.

UNIT I IMAGE FUNDAMENTALS AND TRANSFORMS 9

Elements of Digital image processing systems-Digital image representation- visual perception-Sampling, Quantization, Image basis function- Two dimensional DFT- Discrete cosine transform –Walsh-Hadamard transform-Wavelet transform-Principal Component Analysis-Color image Processing.

UNIT II IMAGE ENHANCEMENT 9

Basic grey level transformation –Contrast stretching - Histogram equalization – Image subtraction – Image averaging –Spatial filtering: Smoothing, sharpening filters – Laplacian filters – Frequency domain filters: Smoothing – Sharpening filters – Homomorphic filtering - Morphological Operations.

UNIT III IMAGE RESTORATION AND COMPRESSION 9

Image restoration-Degradation model-Unconstrained and Constrained restoration –Inverse filtering – Wiener filter-Restoration in spatial domain-Image Compression-Transform coding-Vector Quantization-Hierarchical and progressive compression methods

UNIT IV IMAGE ANALYSIS 9

Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding methods, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm.

UNIT V PATTERN RECOGNITION 9

Recognition based on Decision Theoretic methods-Structural Recognition- Linear Discriminant Analysis – Baye's Classifier – Neural net- Fuzzy system – Optimization Techniques in Recognition - Applications in particle size measurement – Flow measurement - Food processing – Case studies.

TOTAL 45 PERIODS

REFERENCE BOOKS

1 Rafael C.Gonzalez and Richard E.Woods, "Digital Image Processing" Prentice Hall, Third Edition, 2007.
2 William K.Pratt, "Digital Image Processing", Wiley-Interscience, Fourth Edition, 2007.
3 Rafael C.Gonzalez and Richard E.Woods, "Digital Image Processing using MATLAB",

Gatesmark Publishing, Second Edition, 2009.
4 M. Sonka, V.Hlavac and R.Boyle, "Image Processing Analysis and Machine Vision", CL Engineering, Third Edition, 2007.
5 A.K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall, First Edition,1988.

IN7003 ADVANCED OPERATING SYSTEM PRINCIPLES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To introduce fundamental concepts and mechanisms of advanced operating system.
- To provide a basic foundation in the design of operating system.
- To provide various alternative approaches to the solution of the problems encountered in the design of operating system.

COURSE OUTCOMES

- Ability to have the knowledge of distributed operating systems.
- Ability to implement the state of art techniques to address the various design issues in advanced operating system.

UNIT I OPERATING SYSTEM 9

Introduction – operating systems and services – CPU scheduling approaches – Process synchronization semaphores – Deadlocks – Handling deadlocks – Multithreading.

UNIT II DISTRIBUTED SYSTEMS 9

Introduction – Advantages of distributed system over centralized system, Limitations of distributed system, Communication in distributed systems – ATM, Client-Server model distributed operating system – Issues, Communication primitives – Message passing model, Remote procedure call.

UNIT III SYNCHRONIZATION IN DISTRIBUTED SYSTEMS 9

Clock synchronization – Lamport's logical clock, Vector clock, Causal ordering of messages, Causal ordering of messages, Mutual exclusion – Non token based and token based algorithm, Atomic transactions, Distributed deadlock detection and prevention.

UNIT IV DISTRIBUTED RESOURCE MANAGEMENT 9

Distributed file system – Trend, design and implementation, Distributed Shared Memory (DSM) – Memory coherence, Page based DSM, Shared variable DSM, Object based DSM, Distributed scheduling.

UNIT V FAILURE RECOVERY AND FAULT TOLERANCE 9

Recovery – Classification, Backward and forward error recovery, Recovery in concurrent systems, synchronous check pointing and recovery, Check pointing for Distributed database system, Fault tolerant – commit protocols, Voting protocols, Dynamic vote reassignment protocol, Failure Resilient processes.

TOTAL 45 PERIODS

REFERENCE BOOKS

1. Mukesh Singhal and Niranjan G. Shivaratri, "Advanced Concepts in Operating Systems", Tata McGraw Hill, 2001.

2. Abraham Silberschatz, Peter B. Galvin and Greg Gagne, “Operating Systems Concepts”, John Wiley, Eighth edition, 2008.
3. William Stallings, “Operating Systems: Internals and Design Principles”, Pearson Education, Seventh edition, 2011.
4. Andrew S. Tanenbaum, “Distributed Operating Systems”, Pearson Education, 1995.

IN7004	APPLIED BIOMEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the principles and design issues of biomedical instrumentation
- To understand the nature and complexities of biomedical measurements

COURSE OUTCOMES

- Ability to apply fundamental principles for designing and modelling biomedical systems.
- Ability to use mathematical/computational tools for biomedical image and signal analysis

UNIT I INTRODUCTION TO BIOMEDICAL MEASUREMENTS 9

Physiological systems and measurable variables- Nature and complexities of biomedical measurements- Medical equipment standards- organization, classification and regulation- Biocompatibility - Human and Equipment safety – Physiological effects of electricity, Micro and macro shocks, thermal effects.

UNIT II ADVANCES IN MODELING AND SIMULATIONS IN BIOMEDICAL INSTRUMENTATION 9

Modeling and simulation in Biomedical instrumentation – Difference in modeling engineering systems and physiological systems – Model based analysis of Action Potentials - cardiac output – respiratory mechanism - Blood glucose regulation and neuromuscular function.

UNIT III BIOMEDICAL SIGNALS AND THEIR ACQUISITIONS 9

Types and Classification of biological signals – Signal transactions – Noise and artifacts and their management - Biopotential electrodes- types and characteristics - Origin, recording schemes and analysis of biomedical signals with typical examples of Electrocardiography(ECG), Electroencephalography(EEG), and Electromyography (EMG)– Processing and transformation of signals-applications of wavelet transforms in signal compression and denoising.

UNIT IV INSTRUMENTATION FOR DIAGNOSIS AND MONITORING 9

Advanced medical imaging techniques and modalities -Instrumentation and applications in monitoring and diagnosis- Computed tomography, Magnetic Resonance Imaging and ultrasound- Algorithms and applications of artificial intelligence in medical image analysis and diagnosis-Telemedicine and its applications in telemonitoring.

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UNIT V BIOMEDICAL IMPLANTS AND MICROSYSTEMS 9

Implantable medical devices: artificial valves, vascular grafts and artificial joints- cochlear implants - cardiac pacemakers – Microfabriation technologies for biomedical Microsystems-microsensors for clinical applications – biomedical microfluid systems

TOTAL 45 PERIODS

REFERENCE BOOKS

1 John G.Webster, “Bioinstrumentation”, John Wiley & Sons, 2008.
2 Shayne C.Gad, “Safety Evaluation of Medical Devices”, CRC Press, Second Edition, 2002.
3 Michael C.K.Khoo, “Physiological Control Systems: Analysis, Simulation and Estimation, IEEE Press, 2000.
4 John G.Webster, “Medical Instrumentation Application and Design”, John Wiley & Sons, Third Edition, 2009.
5 L.Cromwell, Fred J.Weibell and Erich A.Pfeiffer, “Biomedical Instrumentation and Measurements”, Prentice Hall of India, Digitized 2010.
6 P.Strong, “Biophysical Measurements”, Tektronix, Digitized 2007.
7 K.Najarian and R. Splinter, “Biomedical Signal and Image Processing”, CRC Press, 2005.
8 John L.Semmlow, “Biosignal and Biomedical Image Processing”, CRC Press, First Edition, 2004.
9 Joseph J.Carr and John M.Brown, “Introduction to Biomedical Equipment Technology”, Prentice Hall, Fourth Edition, 2004.

IN7005	APPLIED SOFT COMPUTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To review the fundamentals of ANN and fuzzy set theory
- To make the students understand the use of ANN for modeling and control of non-linear system and to get familiarized with the ANN tool box.
- To give exposure to the different ANN architectures and online training algorithm.
- To impart knowledge of using Fuzzy logic for modeling and control of non-linear systems and get familiarized with the FLC tool box.
- To familiarize the students on various hybrid control schemes, P.S.O and get familiarized with the ANFIS tool box.

COURSE OUTCOMES

- Will be able to know the basic ANN architectures, algorithms and their limitations.
- Also will be able to know the different operations on the fuzzy sets.
- Will be capable of developing ANN based models and control schemes for non-linear system.
- Will get expertise in the use of different ANN structures and online training algorithm.
- Will be knowledgeable to use Fuzzy logic for modeling and control of non-linear systems.
- Will be competent to use hybrid control schemes and P.S.O and support vector Regressive.

UNIT I OVERVIEW OF ARTIFICIAL NEURAL NETWORK (ANN) & FUZZY LOGIC 9

Review of fundamentals - Biological neuron, Artificial neuron, Activation function, Single Layer Perceptron – Limitations – Multi Layer Perceptron – Back propagation algorithm (BPA); Fuzzy set theory – Fuzzy sets – Operation on Fuzzy sets - Scalar cardinality, fuzzy cardinality, union and intersection, complement (yager and sugeno), equilibrium points, aggregation, projection, composition, decomposition, cylindrical extension, fuzzy relation – Fuzzy membership functions.

UNIT II NEURAL NETWORKS FOR MODELLING AND CONTROL 9

Modeling of non linear systems using ANN- NARX,NNSS,NARMAX - Generation of training data - optimal architecture – Model validation- Control of non linear system using ANN- Direct and Indirect neuro control schemes- Adaptive neuro controller – Case study - Familiarization of Neural Network Control Tool Box.

UNIT III ADVANCED ANN STRUCTURES AND ONLINE TRAINING ALGORITHMS 9

Recurrent neural network (RNN)- Adaptive resonance theory (ART)based network- Radial basis function network- Introduction to Complex Neural Network - Online learning algorithms: BP through time, RTRL algorithms, Least Mean square algorithm and Reinforcement learning

UNIT IV FUZZY LOGIC FOR MODELLING AND CONTROL 9

Modeling of non linear systems using fuzzy models(Mamdani and Sugeno) –TSK model - Fuzzy Logic controller – Fuzzification – Knowledge base – Decision making logic – Defuzzification-Adaptive fuzzy systems- Case study - Familiarization of Fuzzy Logic Tool Box.

UNIT V HYBRID CONTROL SCHEMES 9

Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS –Optimization of membership function and rule base using Genetic Algorithm Particle Swarm Optimization - Case study–Introduction to Support Vector Regression – Familiarization of ANFIS Tool Box.

TOTAL 45 PERIODS

REFERENCE BOOKS

1 Laurene V.Fausett, “Fundamentals of Neural Networks, Architecture, Algorithms, and Applications”, Pearson Education, 2008.
2 Timothy J.Ross, “Fuzzy Logic with Engineering Applications”, Wiley, Third Edition, 2010.
3 George J.Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic: Theory and Applications”, Prentice Hall, First Edition, 1995.
4 David E.Goldberg, “Genetic Algorithms in Search, Optimization, and Machine Learning”, Pearson Education, 2009.
5 W.T.Miller, R.S.Sutton and P.J.Webrose, “Neural Networks for Control”, MIT Press, 1996.
6 C.Cortes and V.Vapnik, "Support-Vector Networks, Machine Learning”, 1995.

IN7006	BIOMEDICAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce fundamental, theoretical and methodological principles of biosignal processing and analysis
  - To estimate parametric models of the measured biosignals for prediction, simulation and diagnostic purposes

COURSE OUTCOMES

- Ability to estimate suitable models of the measured biosignals
- Ability to use mathematical/computational tools for biomedical image and signal analysis

UNIT I INTRODUCTION TO SIGNALS 9

Sources of Biomedical signals, types of signals – Deterministic, stochastic, fractal and chaotic, auto correlation, cross correlation, auto covariance, DFT, FFT algorithm – Digital filters – Introduction to FIR and IIR filter.

UNIT II CLASSICAL SPECTRAL ESTIMATION TECHNIQUES 9

Periodogram, Blackman – Tukey spectral Estimation applications – analysis of the Doppler signal using the Periodogram, analysis of Auditory Evoked potentials (AEP) using periodogram, analysis of Heart rate variability using the periodogram cepstrum anlaysis – Cepstra, power cepstrum, applications of cepstrum analysis – analysis of the ECG signal using cepstrum technique, analysis of Diastolic Heart sound using cepstrum technique.

UNIT III ADAPTIVE NOISE CANCELLATION 9

Introduction, principle of adaptive noise canceling, adaptive Noise cancellation with the LMS and RLS adaptation algorithm - applications – adaptive noise canceling method to enhance ECG monitoring, adaptive noise canceling method to enhance Fetal ECG monitoring, adaptive noise canceling method to enhance Electro gastric measurements.

UNIT IV PARAMETRIC MODELING METHODS 9

Autoregressive (AR) methods – Linear Prediction and Autoregressive methods, the autocorrelation (Yule - walker) methods, applications of AR methods AR modeling of seizure EEG, ECG signals and surface EMG. Autoregressive Moving Average (ARMA) method – MLE method, Akaike method, Durbin method, applications – ARMA modeling of somatosensory Evoked Potentials (SEPs), Diastolic Heart sounds and cutaneous Electro gastric signals.

UNIT V NON LINEAR BIOSIGNAL PROCESSING AND WAVELET TRANSFORM 9

Clustering methods – hard and fuzzy clustering, applications of Fuzzy clustering to Biomedical signal processing, Neural Networks – Introduction – NN in processing and analysis of Biomedical signals wavelet transform – Introduction, Filter bank implementation of discrete wavelet transform, signal Denoising using wavelet transform, wavelet based compression.

TOTAL 45 PERIODS

REFERENCE BOOKS

1 M.Akay, “Biomedical Signal Processing”, Academic Press, San Diego, 1994.
2 M.Akay, “Nonlinear Biomedical Signal Processing”, Fuzzy Logic, Neural Networks and New Algorithms, vol.1, IEEE Press Series on Biomedical Engineering, New York, 2000.
3 Eugene N.Bruce, “Biomedical Signal Processing and Signal Modeling”, John Wiley & Sons, First Edition, 2000.

IN7007 EMBEDDED SYSTEMS ARCHITECTURE

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To introduce the Building blocks of Real Time Embedded System
- To familiarize the embedded hardware components & its interface
- To impart knowledge on embedded software development process
- To make the students understand the Real Time Operating Systems
- To give exposure to the Case studies in various fields

COURSE OUTCOMES

- Ability to select embedded hardware components & its interface
- Gain knowledge on embedded software development process
- Acquire knowledge on Real Time Operating Systems
- Gain expertise in the Case studies in various fields

UNIT I INTRODUCTION TO REAL TIME SYSTEMS 9

Fundamentals of systems and real time system - Definitions, classification, Characteristics-Basic model of Real Time Systems – Timing constraints – Safety and Reliability- Typical applications of Real Time Systems.

UNIT II EMBEDDED SYSTEM COMPONENTS AND ITS INTERFACE 9

Embedded system definition- architecture and standards with examples - Embedded hardware-processors-memory devices-Interface and Peripherals- ARM processor based embedded boards - Power and its Management.

UNIT III EMBEDDED SYSTEM SOFTWARE DEVELOPMENT 9

Software embedded in a system – IDE , Assembler, Compiler ,linker, simulator,debugger,In - circuit Emulator(ICE), Target hardware debugging , Program modeling – Program models, Data flow model, State machine programming models, UML models - High level language descriptions in embedded system, Java based embedded system design.

UNIT IV RTOS BASED EMBEDDED SYSTEM DESIGN 9

Introduction to basic concepts of RTOS –Task, Process and Threads, Interrupt routines in RTOS, Multiprocessing & Multitasking, Preemptive and non-Preemptive scheduling, Task communication – shared memory –Inter Process communication – synchronization between processes – semaphores, mail box, pipes, priority Inversion, priority Inheritance, comparison of Real time operating systems: Vxworks, µC/OS II.

UNIT V CASE STUDIES 9

Case studies of Embedded System Design and Coding in application areas of digital consumer electronics , automotives and networking/communication.

TOTAL 45 PERIODS

REFERENCE BOOKS

1 T.Noergaard , "Embedded Systems Architecture : A Comprehensive Guide for Engineers and Programmers", Elsevier Publications, 2010.
2 A.S.Berger, "Embedded System Design : An Introduction to Process, Tools and Techniques", CMP Books, 2008.
3 D.D.Gajski, F.Vahid, S.Narayan, "Specification and Design of Embedded Systems", PTR Prentice Hall, 2002
4 D.E.Simon, "An Embedded Software Primer", Addison Wesley, 2000.
5 Kai Qian, David Den haring, Li Cao, "Embedded Software Development with C", Springer, 2009.

IN7008	INDUSTRIAL DRIVES AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To give an overview on fundamental aspects of motor-load systems and basic characteristics of dc and ac drives.
- To introduce various modeling methods of dc and ac drives.
- To give detailed knowledge on operation, analysis and control of converter and chopper driven dc drives
- To give exposure to principle, techniques of conventional control of ac drives
- To introduce advanced control strategies of ac drives and latest developments in the field of control of electric drives.

COURSE OUTCOMES

Students

- Get a thorough understanding of motor-load system dynamics and stability, modern drive system objectives and fundamentals of dc and ac motors.
- Will have the ability to model both dc and ac motors in various conventional methods.
- Confidently design and analyze both converter and chopper driven dc drives
- Will have a thorough understanding of conventional control techniques of ac drives and will have the ability to design and analyze such system
- Get a detailed knowledge on advanced high performance control strategies for ac drives and emerging technologies in electric drives.

UNIT I INTRODUCTION TO ELECTRIC DRIVES 9

Motor-Load system–Dynamics, load torque, steady state stability, Multi quadrant operations of drives. DC motors- speed reversal, speed control and breaking techniques, Characteristics of Induction motor and Synchronous motors-Dynamic and regenerative braking ac drives.

UNIT II MODELING OF DC AND AC MACHINES 9

Circuit model of Electric Machines-Transfer function and State space models of series and separately excited DC motor-AC Machines –Dynamic modeling –linear transformations-equations in stator, rotor and synchronously rotating reference frames-flux linkage equations-Dynamic state space model-modeling of Synchronous motor

UNIT III CONTROL OF DC DRIVES **9**

Analysis of series and separately excited DC motor with single phase and Three phase converters operating in different modes and configurations- Analysis of series and separately excited DC motor fed from different choppers,-two quadrant and four quadrant operation-Closed loop control of dc drives-Design of controllers

UNIT IV CONTROL OF AC DRIVES **9**

Operation of induction motor with non-sinusoidal supply waveforms, Variable frequency operation of 3-phase inductions motors, constant flux operation, current fed operations, Constant torque operations, Static rotor resistance control and slip power recovery scheme –Synchronous motor control, control of stepped motors, Parameter sensitivity of ac drives.

UNIT V ADVANCED CONTROL OF AC DRIVES **9**

Principles of vector control –Direct and indirect vector control of induction motor –DTC- sensor less vector control-speed estimation methods-Applications of Fuzzy logic and Artificial Neural Network for the control of AC drives.

TOTAL 45 PERIODS

REFERENCE BOOKS

1 G.K.Dubey, "Power Semiconductor Controlled Drives," Prentice Hall International, New Jersey, 1989.

2 Paul .C.Krause, Oleg wasynczuk and Scott D.Sudhoff, "Analysis of Electric Machinery and Drive Systems", 2ndedition , Wiley-IEEE Press, 2002.

3 Bimal K Bose, "Modern Power electronics and AC Drives", Pearson education Asia, 2002.

4 R .Krishnan, "Electrical Motor Drives- Modeling, Analysis and Control", Prentice Hall of India Pvt Ltd., 2nd Edition, 2003.

IN7009 INSTRUMENTATION IN PETROCHEMICAL INDUSTRY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

To enable students to acquire knowledge about

- The different methods of crude oil recovery, processing and refining
- Important Unit operations in petroleum refinery and petrochemical industry
- Production routes of important petrochemicals, and
- Control of selected petrochemicals production processes.
- Hazards and therefore the necessary **safety** measure in planning and function of petrochemical Industry.

COURSE OUTCOME

After completing this course the student will:

- Gain basic knowledge about the methodologies applied for recovery and processing of petroleum.
- Be familiar with different unit operations involved in Petroleum industry.
- Have a general understanding of the production routes for important petrochemicals.
- Be able to describe the control of Important processes like FCCU, Catalytic Reformer, Alkylation.
- Be able to classify the hazardous zones and gain knowledge about the techniques used to reduce the explosion hazards.

UNIT I OIL EXTRACTION AND PROCESSING 9

Techniques used for oil discovery:-seismic survey - methods of oil extraction - oil rig system – Primary, Secondary and Enhanced oil recovery - separation of gas and water from oil - control loops in oil gas separator - scrubber – coalescer.

UNIT II PETROLEUM REFINING 9

Petroleum refining process - unit operations in refinery :- thermal cracking - catalytic cracking - catalytic reforming - polymerization - isomerization - alkylation - Production of ethylene, acetylene and propylene from petroleum.

UNIT III CHEMICALS FROM PETROLEUM 9

Chemicals from methane, acetylene, ethylene and propylene - production routes of important petrochemicals such as polyethylene, polypropylene, ethylene dioxide, methanol, xylene, benzene, toluene, styrene, VCM and PVC.

UNIT IV CONTROL LOOPS IN PETROCHEMICAL INDUSTRY 9

Control of binary and fractional distillation columns - Control of catalytic and thermal crackers - control of catalytic reformer - control of alkylation process - Control of polyethylene production – Control of VCM and PVC production.

UNIT V SAFETY IN INSTRUMENTATION SYSTEM 9

Area and material classification as per National Electric Code (NEC) - Classification as per International Electro technical Commission (IEC) - Techniques used to reduce explosion hazards - Pressurization techniques - Type X, Type Y and Type Z - Intrinsic safety - Mechanical and Electrical isolation - Lower and Upper explosion limit.

TOTAL 45 PERIODS

REFERENCE BOOKS

1. Jens G. Balchen, Kenneth I. Mummé, Process Control: Structures and Applications, Von Nostrand Reinhold Company, New York, 1995.
2. Håvard Devold, “Oil and Gas Production Handbook-An Introduction to Oil and Gas Production” ABB ATPA Oil and Gas, 2006.
3. Béla G. Lipták, “Instrumentation in Process Industries”, Chilton Book Company, 2005.
4. Austen Lawrence Waddams, “Chemical from Petroleum”, Butter and Janner Ltd., 1968.
5. Ram Prasad, Petroleum Refining Technology, Khanna Publishers, New Delhi, 2000.

IN7010	OPTIMAL CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To give exposure to different type of optimal control problems such as time-optimal, fuel optimal, energy optimal control problems
- To impart knowledge and skills needed to design Linear Quadratic Regulator for Time-invariant and Time-varying Linear system (Continuous time and Discrete-time systems)
- To introduce concepts needed to design optimal controller using Dynamic Programming Approach and H-J-B equation.
- To give exposure to various types of fault tolerant control schemes such as Passive and active approaches
- To introduce concepts needed to design optimal controller in the presence of state constraints and time optimal controller

COURSE OUTCOMES

- Ability to explain different type of optimal control problems such as time-optimal, fuel optimal, energy optimal control problems
- Ability to design Linear Quadratic Regulator for Time-invariant and Time-varying Linear system (Continuous time and Discrete-time systems)
- Ability to design optimal controller using Dynamic Programming Approach and H-J-B equation.
- Ability to Explain the Pontryagin Minimum Principle.
- Ability to design optimal controller in the presence of state constraints and time optimal controller.

UNIT I CALCULUS OF VARIATIONS AND OPTIMAL CONTROL 9

Introduction – Performance Index- Constraints – Formal statement of optimal control system – Calculus of variations – Function, Functional, Increment, Differential and variation and optimum of function and functional – The basic variational problem Extrema of functions and functionals with conditions – variational approach to optimal control system

9

UNIT II LINEAR QUADRATIC OPTIMAL CONTROL SYSTEM

Problem formulation – Finite time Linear Quadratic regulator – Infinite time LQR system: Time Varying case- Time-invariant case – Stability issues of Time-invariant regulator – Linear Quadratic Tracking system: Fine time case and Infinite time case

UNIT III DISCRETE TIME OPTIMAL CONTROL SYSTEMS **9**

Variational calculus for Discrete time systems – Discrete time optimal control systems:- Fixed-final state and open-loop optimal control and Free-final state and open-loop optimal control - Discrete time linear state regulator system – Steady state regulator system

UNIT IV PONTRYAGIN MINIMUM PRINCIPLE **9**

Pontryagin Minimum Principle – Dynamic Programming:- Principle of optimality, optimal control using Dynamic Programming – Optimal Control of Continuous time and Discrete-time systems – Hamilton-Jacobi-Bellman Equation – LQR system using H-J-B equation

UNIT V CONSTRAINED OPTIMAL CONTROL SYSTEMS **9**

Time optimal control systems – Fuel Optimal Control Systems- Energy Optimal Control Systems – Optimal Control Systems with State Constraints

TOTAL 45 PERIODS

REFERENCE BOOKS

1 Donald E. Kirk, Optimal Control Theory – An Introduction, Dover Publications, Inc. Mineola, New York, 2004.

2 D. Subbaram Naidu, Optimal Control Systems, CRC Press, New York, 2003.

3 Frank L. Lewis, Draguna Vrabie, Vassilis L. Syrmos, Optimal Control, 3rd Edition, Wiley Publication, 2012.

IN7011 **OPTIMAL STATE ESTIMATION** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To impart Knowledge and Skills
- To design and implement a Discrete Kalman Filter
- To design and implement Extended Kalman Filter, Iterated Extended Kalman Filter, and Second-order Extended Kalman filter
- To design and implement Derivative Free Kalman filter such as Unscented Kalman filter and its variants and Ensemble Kalman Filter
- To design and implement Particle Filter, Unscented Particle Filter

COURSE OUTCOMES

- Ability to Design and Implement Kalman Filter for Linear systems
- Ability to Design and Implement variants of Derivative Based Kalman Filters such as Extended Kalman filter, Iterated Extended Kalman filter, Second order Extended Kalman Filter for non-linear systems
- Ability to Design and Implement variants of Derivative free Kalman Filters such as Unscented Kalman filter, Spherical and Simplex transformations based Unscented Kalman filter
- Ability to Design and Implement variants of H-infinity filters.
- Ability to Design and Implement various types of Particle filters for non-linear and non-Gaussian systems.

UNIT I INTRODUCTION TO STATE ESTIMATION AND KALMAN FILTER 9

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

UNIT II EXTENDED KALMAN FILTER 9

Linearized Kalman filter – Extended Kalman filter – The iterated Extended Kalman filter – The Second order Extended Kalman filter – Constrained Extended Kalman filter – Simultaneous State and Parameter Estimation using EKF – Dual Extended Kalman Filter - Case Studies

UNIT III UNSCENTED KALMAN FILTER 9

Means and Covariance of non-linear transformations – Unscented transformation – Unscented Kalman filtering -General - Unscented transformation - The simplex Unscented transformation – Spherical Unscented transformation - Simultaneous State and Parameter Estimation using UKF Constrained Unscented Kalman filter – Case Studies

UNIT IV THE H-INFINITY FILTER 9

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

UNIT V ENSEMBLE KALMAN FILTER & PARTICLE FILTER 9

Bayesian state Estimation - Ensemble Kalman filter – Introduction to Particle filtering – SIS – Implémentation issues: - Sample Impoverishment - SIR - Particle filter with EKF as proposal - Unscented Particle filter - Case Studies

TOTAL 45 PERIODS

REFERENCE BOOKS

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

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

3 A. Gelb, Applied Optimal Estimation, MIT Press

4 Bruce P. Gibbs, "Advanced Kalman Filtering, Least-Squares and Modeling: A Practical Handbook" Wiley, 2011.

IN7012	ROBOTICS AND AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To make the students understand the basic concepts of robots, their kinematics and trajectory planning of robots
- To elaborate the modeling of robot dynamics using tools such as Euler dynamic model and Lagrangian formulation
- To give an overview of the various methods of control of robots, robotic applications, mobile robots and the related issues in industrial automation

COURSE OUTCOMES

- Ability to analyze the workspace and trajectory panning of robots
- Ability to model the motion of Robots
- Ability to develop application based Robots
- Abiilty to formulate models for the control of mobile robots in various industrial applications

UNIT I INTRODUCTION AND ROBOT KINEMATICS 9

Basic concepts of Robots and automation – classification – specifications – Application – Notation - Direct Kinematics - Co-ordinate frames – rotations - Homogeneous coordinates - The Arm equation - Kinematic analysis of a typical Robot - Inverse Kinematics - Tool configuration - Inverse kinematics of a typical Robot - Workspace analysis and trajectory planning - Work envelope of different robots - The pick and place operation.

UNIT II DYNAMIC OF ROBOTS 9

Continuous path motion-interpolated motion - Straight line motion - Tool configuration Jacobian matrix and manipulator Jacobian - Manipulator Dynamics - Kinetic of potential energy - Energized forces - Lagrange's Equation - Euler Dynamic model.

UNIT III ROBOT CONTROL AND MICRO ROBOTICS 9

The control problem - state equation - Single axis PID control - PD gravity control -Computed torque control - Variable Structure control - Impedance control. Micro Robotics and MEMS - Fabrication technology for micro robotics, Stability issues in legged robots, under actuated manipulators.

UNIT IV ROBOT VISION 9

Fundamentals of Robot applications - Robot vision – Image representation – Template – matching - polyhedral objects - Shape analysis - Segmentation – Iterative processing -Robot cell design -Types of applications - material handling applications - Machine loading and unloading - spot welding - arc welding - spray painting.

UNIT V MOBILE ROBOTS AND CONTROL ISSUES 9

Industrial automation - General layout - general configuration of an automated flow line - conveyor systems - major features – types - Roller, State wheel, Belt, Chain and overhead trolley - Inspection station with feedback loops to up steam workstations - shop floor control - 3 phases - order scheduling.

TOTAL 45 PERIODS

REFERENCE BOOKS

1. Saeed B. Niku, "An Introduction to Robotics- Analysis, Systems, Applications", Second Edition, John Wiley & Sons Inc., 2010.
2. Thomas R. Kurfess, "Robotics and Automation Handbook", CRC Press, 2004.
3. Robert Joseph Schilling, "Fundamentals of Robotics: Analysis and Control", Prentice Hall of India Pvt. Ltd., 1990

IN7013 **SYSTEM IDENTIFICATION**

	L	T	P	C
	3	0	0	3

COURSE OBJECTIVES

- To give an overview on the different data driven identification methods
- To make the student understand the principles of relay based identification
- To enable the student to select a suitable model for identification
- To elaborate the concept of estimating the parameters of the selected models using parameter estimation algorithm
- To provide the background on the practical aspects of conducting experiments for real time system identification

COURSE OUTCOMES

- Ability to develop various models from the experimental data
- Will be able to select a suitable model and parameter estimation algorithm for the identification of systems
- Will be able to carry out the verification and validation of identified model
- Will gain expertise on using the model for prediction and simulation purposes and for developing suitable control schemes

UNIT I INTRODUCTION **9**

System Identification-motivation and overview - Non-parametric methods: Impulse response, step response and Frequency response methods, correlation and spectral analysis methods.

UNIT II PARAMETER ESTIMATION METHODS **9**

Parametric model structures-ARX, ARMAX, OE, BJ models - Linear regression - Least square estimates, statistical properties of LS Estimates. Weighted least squares, maximum likelihood estimation, Prediction error methods, Instrumental variable methods, Recursive Least squares method- Exercises using system identification toolbox.

UNIT III RELAY FEEDBACK IDENTIFICATION **9**

A generalized relay feedback identification method – model; structure selection- relay feedback identification of stable processes: FOPDT and SOPDT model. Relay feedback Identification of unstable processes: FOPDT and SOPDT model. Illustrative examples

UNIT IV CLOSED- LOOP IDENTIFICATION **9**

Identification of systems operating in closed loop: Identifiability considerations – direct identification – indirect identification - Subspace Identification methods : classical and innovation forms, free and structures parameterizations.

UNIT V PRACTICAL ASPECTS OF IDENTIFICATION **9**

Practical aspects: experimental design – input design for identification, notion for persistent excitation, drifts and de-trending – outliers and missing data – pre-filtering -robustness – Model validation and Model structure determination-case studies. Introduction to Nonlinear System Identification.

TOTAL 45 PERIODS

REFERENCE BOOKS

1 Karel J. Keesman," System Identification an Introduction ",Springer, 2011.

2 Lennart Ljung, "System Identification: Theory for the user", Second edition, Prentice Hall, 1999.

3 Tao Liu, Furong Gao, "Industrial Process Identification and control design, Step-test and relay-experiment-based methods", Springer- Verilog London Ltd, 2012.

IN7014	THERMAL POWER PLANT INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

After completion of the course the students will acquire extensive knowledge about:

- Operation & importance of Instrumentation in Thermal power plant
- Development of Mathematical model of different systems in Thermal power plant
- Conventional and advanced control schemes applied to various processes in Thermal Power Plant
- Measurement of important parameters and control techniques applied to steam turbines
- Calculation and optimization of Boiler efficiency by including various losses in thermal power plant

COURSE OUTCOME

- The student will be equipped with the basic knowledge of function of different systems in Thermal power plant
- The student knows the procedural steps to obtain the mathematical model of various units in Thermal power plant
- Will be able to explain conventional and advanced control concepts and theirs implementation in various processes.
- Will get idea on the parameters to be monitored, measured and controlled in steam turbines
- Calculation and optimization of Boiler efficiency by including various losses in thermal power plant

UNIT I BASICS OF THERMAL POWER PLANT **9**

Process of power generation in coal – fired and oil-fired thermal power plants- Types of Boilers-Combustion process – Super heater – Turbine – Importance of Instrumentation in thermal power plants.

UNIT II BOILER MODELING **9**

Development of first principle and data driven models:- combustion chamber, boiler drum,superheater and attemperator

UNIT III BOILER CONTROL **9**

Combustion control-Air/fuel ratio control-furnace draft control –Drum level control –Steam temperature Control– DCS in power plant – Interlocks in Boiler Operation- Model predictive control of super heater – control of drum level using AI techniques.

UNIT IV TURBINE & ALTERNATOR - MONITORING AND CONTROL **9**

Measurement of speed, vibration, shell temperature of steam turbine – Steam pressure Control – Speed control of turbine – Alternator- Monitoring voltage and frequency –Operation of several units in parallel- Synchronization.

UNIT V OPTIMIZATION OF THERMAL POWER PLANT OPERATION **9**

Determination of Boiler efficiency – Heat losses in Boiler – Effect of excess air –Optimizing total air supply- Combustible material in ash- Reduction of turbine losses-Choice of optimal plant parameters- Economics of operation.

TOTAL 45 PERIODS

REFERENCE BOOKS

1. A.B.Gill, “Power Plant Performance”, Elsevier India, New Delhi , 2003.
2. S.M.Elonko and A.L.Kohal, “Standard Boiler Operations”, McGraw Hill, New Delhi, 1994.
3. Sam G. Duke Low, “The Control of Boiler”, ISA press, 1991
4. R.K.Jain, “Mechanical and Industrial Measurements”, Khanna Publishers, New Delhi, 1995.

IN7015	VIRTUAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To provide the background for developing a VI
- To make the student become competent in using state-of-the-art VI tools.
- To enable the student to gain experience in data acquisition and instrument control

COURSE OUTCOMES

- Ability to develop software program called VI
- Student will be able to experiment with plug-in DAQ interfaces for prototype measurement systems

UNIT I INTRODUCTION **9**

Virtual Instrumentation: Historical perspective - advantages - block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - data-flow techniques, graphical programming in data flow, comparison with conventional programming.

UNIT II VI PROGRAMMING TECHNIQUES **9**

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, State machine, string and file I/O.

UNIT III DATA ACQUISITION **9**

Introduction to latest ADCs, DACs. Introduction to PC based data acquisition - typical plug-in data acquisition board - multiplexing of analog inputs - single ended and differential inputs - different strategy for sampling of multi channel analog inputs. Concept of universal DAQ card - use of timers/counters

UNIT IV VI TOOLSETS **9**

Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, windowing and filtering. Simulation of level, thermal, reactor processes. On-Off controller PID Controller.

UNIT V APPLICATIONS **9**

Distributed I/O modules-Virtual Laboratory, Virtual Oscilloscope, Virtual function generator, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

TOTAL 45 PERIODS

REFERENCE BOOKS

1. Robert H.Bishop, “ LabVIEW 2009 Student Edition”, Pearson College Division, 2009.
2. N.Mathivanan, “PC-based Instrumentation :Concepts and Practice”, Eastern Economy Edition, PHI Learning private ltd ,2007.
3. Kevin James, “PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control”, Newnes, 2000.
4. Jovitha Jerome, “Virtual Instrumentation Using LabVIEW”, Eastern Economy Edition, PHI Learning private ltd ,2010.

IN7016	VLSI SYSTEM DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the fundamentals of various MOS device characteristics.
- To familiarize the design rules and layout for NMOS and CMOS.
- To give exposure on the design of simple examples using various logic design methods.
- To lay foundation about issues involved in the selection of PLD.
- To impart knowledge on implementation of the above design in VHDL programming environment.

COURSE OUTCOMES

- Will be able to gain the knowledge of the characteristics and performance of MOS devices.
- Will have an exposure to design of stick diagrams and layout of gates.
- Ability to carry out design of simple circuits using various logic schemes.
- Will be able to select appropriate PLD for an application.
- Will gain expertise in developing and effectively synthesizing VDHL programs for combinational and sequential applications.

UNIT I BASIC DEVICE CHARACTERISTICS 9

NMOS, PMOS, enhancement and depletion mode transistor, MOSFET threshold voltage, linear and saturated operation, standard CMOS inverter, transit time and switching speed of NMOS and CMOS inverters. Circuit characteristics and performance estimation: delay estimation, transistor sizing, power distribution, scaling, noise margin and latch up.

UNIT II DESIGN RULES AND LAYOUT 9

Purpose of design rules, NMOS and CMOS design rules and layout, Design of NMOS and CMOS inverters, NAND and NOR gates. Stick diagrams and layout of logic gates.

UNIT III VLSI SUBSYSTEM DESIGN **9**

Pass Transistor Logic, transmission gate logic, NMOS logic, Static/Dynamic CMOS logic and BiCMOS logic. Design examples: logic gates, multiplexer, flip flop and shift registers.

UNIT IV FPGAs AND CPLDs **9**

Introduction to PLDs -PLA, PAL, GAL. FPGA: Architecture, logic element, interconnects technology. CPLD: Architecture, logic array block, Macrocell, PIA Technology. Specific GAL, FPGA and CPLD devices from Altera / Xilinx.

UNIT V PRINCIPLES OF HDL **9**

VHDL design Entity- Signal and Variable - Concurrent Assignment Statements – Sequential Assignment Statements – Combinational circuits: Multiplexers, adders, priority encoder. Sequential circuits: different types of flip flops, registers, shift register and counters. An introduction to High level VLSI synthesis and design tools. Realizing PID controller in VHDL.

TOTAL 45 PERIODS

REFERENCE BOOKS

1 Jan M.Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits – A Design Perspective", Second Edition, Prentice Hall, 2003.

2 Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital Logic with VHDL Design", Second edition, McGraw Hill, 2004.

3 Thomas L.Floyd & Jain ,"Digital Fundamentals", Tenth edition, Pearson Education, 2009

4 John P.Uyemura, "Introduction to VLSI Circuits and Systems", First Edition, John Wiley and Sons, 2001.

5 Wayne Wolf, "FPGA – Based System Design", Prentice Hall, 2004.

CL7003 WIRELESS SENSOR NETWORKS

LT P C
3 0 0 3

OBJECTIVES

- To introduce the technologies and applications for the emerging domain of wireless sensor networks,
- To impart knowledge on the design and development of the various layers in the WSN protocol stack
- To elaborate the various issues related to WSN implementations
- To familiarize the students with the hardware and software platforms used in the design of WSN

COURSE OUTCOMES

- Ability to analyze WSN with respect to various performance parameters in the protocol stack
- Ability to understand MAC algorithms and Network protocols used for specific WSN applications
- Design and develop a WSN for a given application

UNIT I INTRODUCTION 9

Challenges for wireless sensor networks, Comparison of sensor network with ad hoc network, Single node architecture – Hardware components, energy consumption of sensor nodes, Network architecture – Sensor network scenarios, types of sources and sinks, single hop versus multi-hop networks, multiple sinks and sources, design principles, Development of wireless sensor networks.

UNIT II PHYSICAL LAYER 9

Wireless channel and communication fundamentals – frequency allocation, modulation and demodulation, wave propagation effects and noise, channels models, spread spectrum communication , packet transmission and synchronization, quality of wireless channels and measures for improvement, physical layer and transceiver design consideration in wireless sensor networks, energy usage profile, choice of modulation, power management.

UNIT II DATA LINK LAYER 9

MAC protocols –fundamentals of wireless MAC protocols, low duty cycle protocols and wakeup concepts, contention-based protocols, Schedule-based protocols, Link Layer protocols – fundamentals task and requirements ,error control ,framing, link management

UNIT IV NETWORK LAYER 9

Gossiping and agent-based uni-cast forwarding , Energy-efficient unicast, Broadcast and multicast, geographic routing , mobile nodes, Data –centric and content-based networking – Data –centric routing, Data aggregation, Data-centric storage, Higher layer design issue

UNIT V CASE STUDIES 9

Target detection and tracking, Habitat monitoring, Environmental disaster monitoring, Practical implementation issues, IEEE 802.15.4 low rate WPAN, Sensor Network Platforms and tools-Sensor node hardware, Node-level software platforms, node –level simulators.

TOTAL : 45PERIODS

REFERENCES

1. Feng Zhao and Leonidas J. Guibas, "Wireless Sensor Networks : An Information Processing Approach", Elsevier, 2004.
2. Holger Karl and Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2007.
3. Ivan Stojmenovic, "Handbook of Sensor Networks: Algorithms and Architectures", Wiley, 2005.
4. Kazem Sohraby, Daniel Minoli and Taieb Znati, "Wireless Sensor Networks :Technology, Protocols and Applications", John Wiley, 2007.
5. Bhaskar Krishnamachari, "Networking Wireless Sensors", Cambridge University Press, 2011.

CL7002	**ROBUST CONTROL**	**L T P C**
		3 0 0 3

OBJECTIVES

- To introduce norms, random spaces and robustness measures
- To educate on H2 optimal control and estimation techniques
- To educate on Hinfinity optimal control techniques
- To educate on the LMI approach of Hinfinity control
- To educate on synthesis techniques for robust controllers and illustrate through case studies

UNIT I INTRODUCTION **9**

Norms of vectors and Matrices – Norms of Systems – Calculation of operator Norms – vector Random spaces- Specification for feedback systems – Co-prime factorization and Inner functions –structured and unstructured uncertainty- robustness

UNIT II H_2 OPTIMAL CONTROL **9**

Linear Quadratic Controllers – Characterization of H_2 optimal controllers – H2 optimal estimation-Kalman Bucy Filter – LQG Controller

UNIT III H-INFINITY OPTIMAL CONTROL-RICCATI APPROACH **9**

Formulation – Characterization of H-infinity sub-optimal controllers by means of Riccati equations – H-infinity control with full information – Hinfinity estimation

UNIT IV H-INFINITY OPTIMAL CONTROL- LMI APPROACH **9**

Formulation – Characterization of H-infinity sub-optimal controllers by means of LMI Approach – Properties of H-infinity sub-optimal controllers – H-infinity synthesis with pole-placement constraints

UNIT V SYNTHESIS OF ROBUST CONTROLLERS & CASE STUDIES **9**

Synthesis of Robust Controllers – Small Gain Theorem – D-K –iteration- Control of Inverted Pendulum- Control of CSTR – Control of Aircraft – Robust Control of Second-order Plant-Robust Control of Distillation Column

TOTAL : 45PERIODS

REFERENCES

1. U. Mackenroth “Robust Control Systems: Theory and Case Studies”, Springer International Edition, 2010.
2. J. B. Burl, “ Linear optimal control H2 and H-infinity methods”, Addison W Wesley, 1998
3. D. Xue, Y.Q. Chen, D. P. Atherton, "Linear Feedback Control Analysis and Design with MATLAB, Advances In Design and Control”, Society for Industrial and Applied Mathematics, 2007.
4. I. R. Petersen, V.A. Ugrinovskii and A. V. Savkin, “Robust Control Design using H-infinity Methods”, Springer, 2000.
5. M. J. Grimble, “Robust Industrial Control Systems: Optimal Design Approach for Polynomial Systems”, John Wiley and Sons Ltd., Publication, 2006.

ET7010 CRYPTOGRAPHY AND NETWORK SECURITY L T P C
3 0 0 3

Pre-requisites:Basics of Signal Processing, Mathematics of Transforms, microcontroller

OBJECTIVES

- To expose the students to the fundamentals of data security.
- To teach the fundamentals of mathematical aspects in creating Encryption keys
- To teach the fundamentals of Security in data communication.
- To teach the fundamentals of Secured system operation.
- To teach the fundamentals of Security in wireless communication.

UNIT I SYMMETRIC CIPHERS 9

Overview – classical Encryption Techniques – Block Ciphers and the Data Encryption standard – Introduction to Finite Fields – Advanced Encryption standard – Contemporary Symmetric Ciphers – Confidentiality using Symmetric Encryption.

UNIT II PUBLIC-KEY ENCRYPTION AND HASH FUNCTIONS 9

Introduction to Number Theory – Public-Key Cryptography and RSA – Key Management – Diffie-Hellman Key Exchange – Elliptic Curve Cryptography – Message Authentication and Hash Functions – Hash Algorithms – Digital Signatures and Authentication Protocols.

UNIT III NETWORK SECURITY PRACTICE 9

Authentication Applications – Kerberos – X.509 Authentication Service – Electronic mail Security – Pretty Good Privacy – S/MIME – IP Security architecture – Authentication Header – Encapsulating Security Payload – Key Management.

UNIT IV SYSTEM SECURITY 9

Intruders – Intrusion Detection – Password Management – Malicious Software – Firewalls – Firewall Design Principles – Trusted Systems.

UNIT V WIRELESS SECURITY **9**

Introduction to Wireless LAN Security Standards – Wireless LAN Security Factors and Issues.

TOTAL : 45 PERIODS

TEXT BOOKS

1. William Stallings, "Cryptography And Network Security – Principles And Practices", Pearson Education, 3rd Edition, 2003.

REFERENCES

1. Atul Kahate, "Cryptography and Network Security", Tata McGraw Hill, 2003.
2. Bruce Schneier, "Applied Cryptography", John Wiley and Sons Inc, 2001.
3. Stewart S. Miller, "Wi-Fi Security", McGraw Hill, 2003.
   Charles B. Pfleeger, Shari Lawrence Pfleeger, "Security In Computing", 3rd Edition, Pearson Education, 2003.
5. Mai, "Modern Cryptography: Theory and Practice", First Edition, Pearson Education, 2003.