COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

DEPARTMENT OF CHEMICAL ENGINEERING

M.Tech. PROCESS DYNAMICS AND CONTROL

VISION AND MISSION OF THE INSTITUTE

VISION OF THE INSTITUTE

The Institute strives to inculcate a sound knowledge in engineering along with realized social responsibilities to enable its students to combat the current and impending challenges faced by our country and to extend their expertise to the global arena.

MISSION OF THE INSTITUTE

To impart high quality education and training to its students to make them World-class engineers with a foresight to the changes and problems, and pioneers to offer innovative solutions to benefit the nation and the world at large.

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VISION AND MISSION OF THE DEPARTMENT

VISION OF THE DEPARTMENT

The Department of Chemical Engineering strives for excellence in all aspects of teaching and research, to produce Chemical Engineers of quality required in Industries/ academic/ research organizations and serves the society at national and international standards.

MISSION OF THE DEPARTMENT

1. To educate the young minds by providing academic and research proficiency to pursue their successful career in industry, academic and research organization.
2. To evolve innovative technologies in the field of chemical engineering towards serving the profession and the community.
3. Nurture students to be dynamic, versatile in their profession and also in the humanism.

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PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

I. Experienced and technically competent engineers in the field of automation and control with a solid foundation in engineering and technology which will enable them to apply a range of different approaches to problem analysis and synthesis as well as different solution strategies in tackling complex technical problems in the industry

II. Have a sound knowledge base and skill sets to develop and expand professional careers in fields related to process modeling and simulation, computer-based control systems, and industrial processes automation

III. Technology pioneers and change agents as they apply their conceptual knowledge and engineering skills not only to design, develop and deploy state of the art automation and control related tools, techniques and technologies but also to catalyze change in the workplace and in the economy at large

IV. Lifelong learners who in a formal sense will go on to enroll in, and successfully graduate from, more advanced graduate and professional education and certification programs that are nationally and/or internationally recognized in engineering, science or business, and who, more informally, are and will remain wise enough to diagnose, analyze and remedy the gaps or deficits in their own knowledge bases over time by gleaning what they can from the environment on their own.

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PROGRAMME OUTCOMES (POS)

a) The graduates have an ability to apply knowledge of advanced mathematics and engineering principles to practical problems in their respective professions.

b) The graduates have an ability to improve the efficiency of processesautomation in the industry.

c) Graduates will be competent in computer applications and be able to develop applications programs for modeling, simulation, automation, and control of engineering systems for problem formulation and solutions.

d) Graduates will be able to solve open-ended technical problems and be proficient in the analysis, design, test, and implementation of instrumentation and control systems utilizing appropriate software and hardware tools and devices.

e) The graduates have an ability to work in multidisciplinary teams consisting of professionals from various disciplines of Engineering.

f) The graduates have an ability to be employed in software based jobs related toindustrial process control design and process simulation.

g) The graduates have an ability to communicate effectively in multicultural environment and work with professional ethics and responsibility.

h) Graduates will conduct, analyze, and interpret experimental results to improve the process.

i) Graduates will be able to understand the value and role of professional organizations as resources for technical information and career direction, be active in networking and community involvements.

j) Graduates will be able to understand and uphold professional, ethical, and social responsibilities.

k) The graduates should engage in continuous improvements and self-evaluation and should demonstrate a commitment to qualityand have the ability to complete work in a timely manner.

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DEPARTMENT OF CHEMICAL ENGINEERING

Curriculum from the Academic Year 2015 – 2016 onwards

M.Tech. Process Dynamics and Control

SUBJECTS OF STUDY

(For the students admitted from the Academic Year 2015 – 2016 onwards)

Semester I							
Course Code	**Course Name**	**Contact Hours**	**L**	**T**	**P**	**C**	**Category**
15MCH11	Linear Algebra, Numerical Methods and Calculus of Variations	4	4	0	0	4	FC
15MPD11	Industrial Process Automation	4	4	0	0	4	PC
15MCH13	Digital Process Dynamics and Control	3	3	0	0	3	PC
15MPD12	Systems Theory	4	4	0	0	4	PC
	Elective I	3	3	0	0	3	PE
15MCH15	Seminar and Technical Writing	2	0	0	2	1	EEC
15MCH16	Process Modeling, Dynamics and Control Laboratory	2	0	0	2	1	PC
	Total					**20**	

Semester II							
Course Code	**Course Name**	**Contact Hours**	**L**	**T**	**P**	**C**	**Category**
15MPD21	System Identification and Adaptive Control	3	3	0	0	3	PC
15MPD22	Computer Control of Process	3	3	0	0	3	PC
15MCH23	Process Modeling, Simulation and Optimization	4	4	0	0	4	FC
15MPD23	Process Monitoring and Fault Diagnosis	4	4	0	0	4	PC
	Elective II	3	3	0	0	3	PE
15MCH25	Professional Engineering Practices	2	0	0	2	1	EEC
15MPD24	Control System Design Laboratory	2	0	0	2	1	PC
	Total					**19**	

Semester III							
Course Code	Course Name	Contact Hours	L	T	P	C	Category
	Elective III	3	3	0	0	3	PE
	Elective IV	3	3	0	0	3	PE
	Elective V	3	3	0	0	3	PE
	Total					**9**	
Semester IV							
Course Code	Course Name		L	T	P	C	Category
15MPD41	Project Work and Viva-Voce		-	-	-	18	EEC
		Total				**18**	

Minimum Number of credits to be earned for the award of degree: 66

LIST OF PROFESSIONAL ELECTIVES

Course Code	Course Name	L	T	P	C
15MPDE 01	Process Flow Sheeting and P&I Diagram	3	0	0	3
15MPDE 02	Nonlinear Control Systems	3	0	0	3
15MPDE 03	Embedded Control Systems	3	0	0	3
15MPDE 04	Neural Network and Fuzzy Systems	3	0	0	3
15MPDE 05	Multivariable Control Systems	3	0	0	3
15MPDE 06	Nonlinear Oscillation	3	0	0	3
15MPDE 07	Robust and Optimal Control	3	0	0	3
15MPDE 08	Pilot Plants, Models and Scale Up Methods	3	0	0	3
15MPDE 09	Probability and Computing	3	0	0	3
15MPDE 10	Project Engineering of Process Plants	3	0	0	3
15MPDE 11	Soft Computing Techniques	3	0	0	3
15MPDE 12	Synchronization and Its Recent Applications in Chaotic Systems	3	0	0	3
15MPDE 13	Embedded Sensors Networks	3	0	0	3
15MPDE 14	Robotics Technology and Intelligence	3	0	0	3
15MPDE 15	Introduction to Chemical Engineering	3	0	0	3
15MPDE 16	Green Technology	3	0	0	3

L: Lecture, T: Tutorial, P: Practical, C: Credits

- FC – Fundamental Course, PC – Professional Course, PE – Professional Elective, EEC – Employment Enhancement course
- Student can opt for a maximum of 2 professional elective subjects from other programmes during their entire programme of study

15MCH11 LINEAR ALGEBRA, NUMERICAL METHODS AND CALCULUS OF VARIATIONS

ASSESSMENT : THEORY

L	T	P	C
4	0	0	4

COURSE OBJECTIVE

- To acquire the mathematical knowledge and skills needed in this course and to provide a basis for more advanced numerical techniques to solve complex engineering problems.
- To interpret and solve a range of authentic engineering problems involving complex algebraic and differential equations.
- To learn number of standard and powerful algorithms, as well as demonstrating methodologies in graph techniques.

COURSE OUTCOME

CO1: To utilize the various numerical techniques to solve system of linear and nonlinear equations.

CO2: To solve simple optimal control problems using the concepts of classical and modern one dimensional calculus of variations.

CO3: To solve isoperimetric problems involving extrema of integrals subject to integral constraints as side conditions.

CO4: To able to obtain approximate values of definite integrals in one or two dimensions, as well as bound their error terms using Gaussian quadrature methods, and Adaptive methods.

LINEAR ALGEBRA-I

System of Linear equations - Solution of linear system - Linear transformations - Matrix of linear transformation - Matrix operations - Inverse of a matrix - Matrix factorizations - Subspaces of Rn - Dimension and Rank - Determinants - Cramer's rule - Matrix factorization - Cholesky decomposition - QR factorization - Singular value decomposition - Toeplitz matrices and some applications. (12)

LINEAR ALGEBRA-II

Vector spaces and subspaces - Null spaces and column spaces - Linearly independent sets - Basis - Coordinate systems - Dimension of a vector space - Rank - Eigenvector and Eigenvalues - Characteristic equation - Diagonalization - Eigenvectors and linear transformations - Orthogonal sets - Gram - Schmidt process - Least square problems - Inner products space.Vector spaces - subspaces - Linear dependence - Basis and Dimension - Inner product spaces - Gram Schmidt Orthogonalization Procedure - transformations - Kernels and Images - Matrix representation oflinear transformation - Change of basis Eigen values and Eigen vectors of linear operator - Quadratic form. (12)

NUMERICAL DIFFERENTIATION AND INTEGRATION

Derivatives from difference tables - Divided differences and finite differences -Numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rules - Romberg's method - Two and Three point Gaussian quadrature formulas - Double integrals using trapezoidal and Simpson's rules. (12)

BOUNDARY VALUE PROBLEMS FOR ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS

Single step methods: Taylor series method - Euler and modified Euler methods - Fourth order Runge - Kutta method for solving first and second order equations - Multistep methods: Milne's and Adam's predictor and corrector methods. Finite difference solution of second order ordinary differential equation - Finite difference solution of one dimensional heat equation by explicit and implicit methods - One dimensional wave equation and two dimensional Laplace and Poisson equations. (12)

CALCULUS OF VARIATIONS

Simple variation problems with fixed boundaries - Euler's equations - conditional extrema isoperimetric problems - approximate solutions - direct methods - Euler's finite difference method - Ritz method. (12)

Total : 60

REFERENCES

1. *Hilder Brand F.B., "Method of Applied Mathematics", Prentice Hall Publications (Private Limited), 1965.*
2. *Venkataraman M.K., "Higher Engineering Mathematics for Engineering and Sciences", National publishing company, 2000.*
3. *Steven Chapra, Raymond P Cannle, " Numerical methods for Engineers", Tata McGrawHill Publications, 6th ed.,2010.*
4. *Vasistha A.R. and Gupta R.K, "Integral Transforms", Krishna Prakashan Media (Private Limited), Meerut(UP), 2000.*
5. *Elsgolts L "Differential equation and Calculus of variations", MIR Publication, Moscow, 1970.*
6. *Narayanan S., ManickavasagamPillay T.K.,Ramanaiah G., "Advanced Mathematics for Engineering students", Viswanathan Printers and Publishers Private Limited, 1986.*
7. *NarasinghDeo, "Graph Theory with Applications to Engineering and Computer Science" Prentice-Hall, 2008.*
8. *Kenneth Hoffman and Ray Kunze, Linear Algebra, 2nd ed., PHI,1971.*

15MPD11 INDUSTRIAL PROCESS AUTOMATION

ASSESSMENT : THEORY

L	T	P	C
4	0	0	4

COURSE OBJECTIVE

- To provide a basic introduction to Programmable Logic Controllers (PLCs) and its use in automation applications.
- To develop the criteria for determining the selection of control valves for specific purposes.
- To identify and design PLC programs to solve sequential control problems.

COURSE OUTCOME

CO1: Ability to develop a PLC program for an automatic control system of a medium degree of complexity and to select the right hardware for a given application.

CO2: Ability to connect the field devices to the PLC to create a complete control system by considering such aspects of the automationsystem as network communication, safety and protection against interference.

CO3: Ability to express different types automation and study both technological and economic issues involved in automatic manufacturing of products.

INTRODUCTION TO AUTOMATION

Introduction to process automation - Role of automation systems in process industry - Types of production systems and their automation - Basic elements of automated system - Introduction to automation tools PLC, DCS, SCADA, Hybrid DCS/PLC. (12)

PROGRAMMABLE LOGIC CONTROLLERS

General PLC Programming Procedure - Programming On/Off Inputs to Produce On-Off Outputs - Relation of Digital Gate Logic to Contact/ Coil Logic - Creating Ladder Diagrams from Process Control Descriptions. (12)

PLC DATA HANDLING AND FUNCTIONS

Data move instructions - table and register moves - PLC FIFO and LIFO functions - Basic PLC Functions - Register Basics - PLC Time Functions - PLC Counter Functions - Intermediate Functions - PLC Arithmetic Functions - PLC Number Comparison Functions - Numbering Systems and PLC Number Conversion Functions. (12)

DISTRIBUTED CONTROL SYSTEMS

Introduction to architecture of different makes - DCS Specifications - configuration of DCS blocks for different applications - Interfacing of protocol based sensors - actuators and PLC systems - Plant wide database management - Security and user access management - MES - ERP (12)

STUDY OF ADVANCE PROCESS CONTROL BLOCKS

Statistical Process Control - Model Predictive Control - Fuzzy Logic Based Control - Neural - Network Based Control - Higher Level Operations : Control & Instrumentation for process optimization Applications of the above techniques to the some standard units/process. (12)

Total : 60

REFERENCES

1. *Jon Stenerson: Programmable Logic Controllers and Industrial Automation, 1st ed., (ISE), 2002.*
2. *John W. Webb, Ronald A. Reis: Programmable Logic Controllers: Principle & Applications, 5th ed., Prentice Hall, 2003.*
3. *MadhuchhandaMitra, SamarjitSengupta: Programmable Logic Controllers and Industrial Automation, 1st ed., 2009.*
4. *Michael .P. Lukas: Distributed Control systems: Their Evaluation and Design, Van Nostrand Reinhold, New York, 1986.*
5. *Stephanopoulos,G. "Chemical Process Control: An Introduction To Theory And Practice" , 6th ed., Prentice Hall of India Pvt.Ltd, New Delhi, 1998.*
6. *Smith C, A. and corrupio A.B. "Principles and Practice of Automative Process control" John Wiley, New York, 1976.*
7. *Astrom k .J and Wittenmurk.B. Computer controlled systems. Theory and design, 2nd ed., Prentice Hall of India Pvt. Ltd., New Delhi,1994.*

15MCH13 DIGITAL PROCESS DYNAMICS AND CONTROL

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To apply the various control methods employed in chemical engineering industries.
- To provide advanced course emphasizing digital control system and introduce the knowledge of Z- transforms.
- To provide the application of control structure formation, theory, tools to formulate the structure in MIMO system.
- To know the use of digital control systems, sampling effects on variables such as Temperature, Pressure, etc.,

COURSE OUTCOME

CO1: To understand the advanced control techniques, ratio, cascade and MPC systems.

CO2: Identify methods for various concepts and in industries to control the variables.

CO3: To understand the concepts of conversion of analog to digital and vice versa, hardware components of the control system.

OPEN AND CLOSED SYSTEM

Review of first order and higher order systems - closed and open loop response to step - impulse and sinusoidal inputs - Design of control systems control valve - types - linear - equal percentage and quick opening valve - Block diagram - presentation of system. (9)

ADVANCED CONTROLLERS

Advanced control techniques, cascade ratio, feed forward, Adaptive control, Selective control, computing relays, simple alarms, smith predictor, internal model control, theoretical analysis of computer process. (9)

MULTIVARIABLE CONTROLLER

Multi loop system - level process, Stability of multi-variable systems, Non-linear systems. Decoupling of control loops and Relative Gain-Array. (8)

DIGITAL CONTROLLERS

Digital computer, computer- process interface, computer control loops, new control design problems, Z-transforms, inversion of Z-transforms. Sampling of continuous signals, reconstruction-hold devices, conversion of continuous to discrete-time models. (10)

DYNAMIC SYSTEM AND STABILITY

Discrete time response of dynamic systems, discrete time analysis of continuous systems, pulse transfer function, discrete time analysis of closed loop system, stability of discrete - time systems. Digital approximation of classical controllers, effect of samples, tuning and process identification. Zeigler - Nicholas and Cohen-Coon tuning methods, ringing and placement of poles, Design of optimal regulatory control problems. (9)

Total : 45

TEXT BOOKS

1. *Stephanopoulos G., Chemical Process Control: An Introduction To Theory And Practice, 6th ed., Prentice Hall of India Pvt.Ltd, New Delhi, 1998.*

2. *Luyben W.K., Luyben M.L., Essentials of process control, 2nd ed., McGraw hill, New York, 1997.*

3. *Cougnowr D., Steven Leblanc, Process Systems Analysis and Control, 3rd ed., McGraw Hill, New York, 2008.*

REFERENCES

1. *Carlos A. Smith, Armando B. Corripio, Principles and Practice of Automative Process control, John Wiley, New York, 2005.*

2. *Karl Johan Astrom, Bjorn Witten mark, Computer controlled systems. Theory and design, 3rd ed., Prentice Hall of India Pvt. Ltd., New Delhi, 1996.*

15MPD12 SYSTEMS THEORY

ASSESSMENT : THEORY

L	T	P	C
4	0	0	4

COURSE OBJECTIVE

- To develop model for first and second-order linear dynamic systems such as mechanical, electrical and thermal-fluid systems, and analyze the linear responses.
- To perform Laplace and inverse Laplace transformation, and to use Laplace transforms to solve ordinary differential equations.
- To identify key characteristics of first- and second-order systems, and use block diagrams to analyze linear system performance.

COURSE OUTCOME

CO1: Ability to employ state-space methods to analyze and design linear feedback control systems.

CO2: Ability to demonstrate knowledge in analyzing the control system performances in the time and frequency domain and analyzing the stability, controllability and observability of control systems.

CO3: Ability to design for state feedback controller with full order observer and reduced order observer for SISO & MIMO Systems.

STATE VARIABLE REPRESENTATION

Introduction - Concept of State - State equation for Dynamic Systems - Time invariance and linearity - Non uniqueness of state model - State Diagrams - Physical System and State Assignment. (12)

SOLUTION OF STATE EQUATION

Existence and uniqueness of solutions to Continuous - time state equations - Solution of Nonlinear and Linear Time Varying State equations - Evaluation of matrix exponential - System modes - Eigenvalues and Eigenvectors. (12)

CONTROLLABILITY AND OBSERVABILITY

Controllability and Observability - Stabilizability and Detectability - Test for Continuous time Systems - Time varying and Time invariant case - Output Controllability - Reducibility - System Realizations. (12)

STABILITY

Introduction - Equilibrium Points - Stability in the sense of Lyapunov - BIBO Stability - Stability of LTI Systems - Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems - The Direct Method of Lyapunov and the Linear Continuous - Time Autonomous Systems -

Finding Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems - Krasovskii and Variable - Gradient Method. (12)

DESIGN

Introduction - Controllable and Observable Companion Forms - SISO and MIMO Systems - The Effect of State Feedback on Controllability and Observability - Pole Placement by State Feedback for both SISO and MIMO Systems - Full Order and Reduced Order Observers. (12)

Total : 60

REFERENCES

1. *Robert L. Williams II & Douglas A. Lawrence, "Linear state space control systems", John Wiley & Sons Inc., 2007.*
2. *Katsuhiko Ogata, "Modern Control Engineering", 5th ed., Prentice Hall India 2010.*
3. *M. Gopal, "Modern Control System Theory", New Age International, 2010.*
4. *John S. Bay, "Fundamentals of Linear State Space Systems", McGraw-Hill, 1999.*
5. *D. Roy Choudhury, "Modern Control Systems", New Age International, 2005.*

15MCH15 SEMINAR AND TECHNICAL WRITING

ASSESSMENT : PRACTICAL

L	T	P	C
0	0	2	1

COURSE OBJECTIVE

- To develop the research skills using primary research to discover and employ technical information.
- To explore the correspondence skills by learning the generic conventions of technical fields.
- To demonstrate promotional writing skills using primary research; to disseminate information in relevance with the research work.
- To familiarize with basic sources and methods of research and documentation on topics in technology, including on-line research. They will be able to synthesize and integrate material from primary and secondary sources with their own ideas in research papers.

COURSE OUTCOME

CO1: Ability to participate actively in writing activities (individually and in collaboration) that model effective scientific and technical communication in the workplace.

CO2: Ability to recognize, explain, and use the theoretical strategies and the formal elements of these the following the specific genres of technical communication such as technical abstracts, data based research reports, instructional manuals, and technical descriptions.

CO3: Ability to collect, analyze, document, and report research clearly, concisely, logically, and ethically; understand the standards for legitimate interpretations of research data within scientific and technical communities.

The students are expected to carry out fundamental theoretical and/or experimental studies, connected with physical properties or on process development studies or a design projects and an oral presentation on the work done. The students should maintain a record of the work done regularly and submit the same periodically for assessment. At the end of the semester, the students must submit a report of the work done in the standard format which will be evaluated by a team of senior faculty members and Head of the Department.

Total : 30

15MCH16 PROCESS MODELING, DYNAMICS AND CONTROL LABORATORY

ASSESSMENT : PRACTICAL

L	T	P	C
0	0	2	1

COURSE OBJECTIVE

- Ability to analyze process dynamics and various forms of mathematical models to express them, including differential equations, Laplace transfer functions, and frequency response plots.
- Develop realistic computer simulation case studies that exhibited nonlinear, high order dynamic behavior.
- Develop convenient graphical interface for students that allowed them to interact in real-time with the evolving virtual experiment.

COURSE OUTCOME

CO1: Able to develop model for the dynamics of engineering systems using fundamental principles.

CO2: Able to explain the frequency response characteristics of linear systems and use them for stability analysis.

CO3: Able to demonstrate the principles of process control strategies in chemical process and develop the ability to design simple proportional-integral and other controllers.

EXPERIMENTS

1. Studies on Indirect Heating (or) Cooling by Transfer of Heat from One Fluid Stream to Another when Separated by a Solid Wall.
2. Performance on Energy Balance across Shell and Tube Heat Exchanger.
3. Studies on the Effect of Heat Transfer, Temperature Efficiencies and Temperature Profile Through a Shell and Tube Heat Exchanger.
4. Estimation of Overall Heat Transfer Coefficient for a Shell and Tube Heat Exchanger using LMTD Method.
5. Measurement of Hot and Cold Fluid Inlet and Outlet Temperature Using Lab VIEW.
6. Design of Closed Loop System of Heat Exchanger Using Lab VIEW.
7. To Study Tuning of PID Controller by Open Loop Method using Zeigler- Nichols Tuning Rules in Temperature Control Trainer.
8. To Study Tuning of PID Controller by Open Loop Method using Zeigler- Nichols Tuning Rules in Level Control Trainer.

9. To Study Tuning of PID Controller by Open Loop Method using Zeigler- Nichols Tuning Rules in Flow Control Trainer.

10. To Study Tuning of PID Controller by Open Loop Method using Zeigler- Nichols Tuning Rules in Pressure Control Trainer.

11. To study steady state and transient response of P+I control.

12. To study steady state and transient response of P+D control.

13. To study steady state and transient response of PID control using closed loop method.

14. To study stability of system by plotting bode plots.

15. Application of ANSYS in CFD problems - Flow problem - (laminar or turbulent flow problems)

16. Application of ANSYS in Electrical problems RF Amplifier - Electrical field problems.

17. Simulation of industrial processes using Software packages like ANSYS, MATLAB,etc.

Total : 30

15MPD21 SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To design and implement system identification of simple real experiments.
- To use input-output experimental data for identification of mathematical dynamical models.
- To use system identification methods to design adaptive controllers.

COURSE OUTCOME

CO1: To explain the use of observers in control system and apply basic system identification and adaptive control methods.

CO2: To Identify and estimate the parameters in the linear and nonlinear models using recursive methods.

CO3: To demonstrate the concept of adaptive control, Gain scheduling Control, MRAC, Direct and Indirect Adaptive Control, Adaptive Pole Placement Control.

NON PARAMETRIC METHODS

Nonparametric methods: Transient analysis, frequency analysis, Correlation analysis, Spectral analysis. (9)

PARAMETRIC METHODS

Linear Regression: The Least square estimate - best liner unbiased estimation under linear constraints - updating the Parameter estimates for linear regression models - Prediction error methods: Description of Prediction error methods - Optimal Prediction - relationships between Prediction error methods and other identification methods theoretical analysis. Instrumental variable methods: description - theoretical analysis - covariance matrix of IV estimates - Comparison of optimal IV prediction error methods. (9)

RECURSIVE IDENTIFICATION METHODS

Recursive least squares method - Recursive Instrumental variable method - Recursive prediction error method - model validation and model structure determination. Identification of systems operating in closed loop: Identifiability considerations - direct identification - Indirect identification - joint input output identification. (9)

ADAPTIVE CONTROL SCHEMES

Introduction - Definitions - auto tuning - types of adaptive control - gain scheduling controller - model reference adaptive control schemes - self tuning controller. MRAC and STC : Approaches - The Gradient approach - Lyapunov functions - Passivity theory - pole placement method.Minimum variance control - Predictive control. (9)

ADAPTIVE CONTROL ISSUES AND APPLICATION

Stability - Convergence - Robustness - Application of adaptive control. (9)

Total : 45

TEXT BOOKS

1. *Soderstorm.T and Petrestioca, System Identification, Prentice Hall International(UK) Ltd. 1989.*

2. *Karl J.Astrom and Bjorn Wittenmark, Adaptive Control, Pearson Education, 2nd ed., 2001.*

REFERENCES

1. *Ljung,L.System Identification: Theory for the user, Prentice Hall, Englewood cliffs, 1987.*

2. *Sastry S. and Bodson M., Adaptive control - Stability, Convergence and Robustness, Prentice Hall Inc., New Jersey, 1989.*

15MPD22 COMPUTER CONTROL OF PROCESS

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To introduce basic fundamentals of Computer based process control and to elaborate different concepts of process control, mathematical modelling of process dynamics.
- To analyze the investigations of the basic computer control schemes starting from sampling to discrete systems, development of pulse transfer functions.
- To introduce stability of discrete control systems and to make students familiar with different digital controllers and their design.

COURSE OUTCOME

CO1: Able to demonstrate the application of different computer process control systems and determine the pulse transfer function of the zero order, first order holds.

CO2: Able to identify the application of different digital controllers and their designs to suitable processes with or without time delay systems.

CO3: Able to describe the advanced control concepts, system identification and process modeling.

INTRODUCTION TO PROCESS CONTROL

Introduction to Process Control: Incentives for process control, Design aspect of process control systems, Process dynamics and mathematical models, Types of dynamic processes.

Computers in Process Control: Advantages, Implementation problems: Sampling, Quantization, Aspects of control theory: Transfer function approach, State space approach. (9)

COMPUTER ORIENTED MATHEMATICAL MODELS

Computer Oriented Mathematical Models: Discrete - time Systems: Mathematical representation of sampling process, Sampling of Continuous - time state space systems, transformation of state space models, Input - output models, Pulse transfer function and data holds, Development of pulse transfer function of the zero and first order holds, Sampling frequency consideration and selection of optimum sampling period. Closed Loop Response and Stability of Sampled Data Systems: Determination of closed loop transient response, Shur - Cohen - Jury Stability criterion. (9)

DIGITAL CONTROLLERS FOR PROCESS CONTROL APPLICATIONS

Digital Controllers for Process Control Applications: A brief review of three term controller and their realization, Implementation aspects: Refinement of three term algorithms, other controllers enhancement: linearization, Adaption, Sample rate selection, Consideration of computational accuracy. (9)

DIGITAL PROCESS CONTROL SYSTEMS

Distributed digital control systems, analog and digital signal data transfer and convertors microprocessors and digital hardware in process control, software organization, process control languages, operator-machine interface. (9)

DESIGN OF CONTROL SYSTEMS FOR COMPLETE PLANTS

Process design and process control, Design and control of storage tanks ,effect of feed effluent heat exchanger on reactor control, poor process design control problems, case study of Hydrodealkylation of toluene plant, control the production rate, material balance control, product quality control, optimizing the operation of a plant (9)

Total : 45

TEXT BOOKS

1. P. B. Deshpande and R. H. Ash, Computer Process Control with advanced control applications, Second Edition, Instrument Society of America Publication, 1988.
2. R. Isermann, Digital Control Systems, Vol.I: Fundamentals, Deterministic Control, Springer-Verlag Publications, 2013.
3. DaleE.Seborg., Thmoas F.Edgar., Duncan A.Mellichamp., Process dynamics and Control., 3rd ed., John Wiley & sons, 2010
4. Stephanopoulos,G. "Chemical Process Control: An Introduction To Theory And Practice", 6th ed., Prentice Hall of India Pvt.cLtd, New Delhi, 1998.

15MCH23 PROCESS MODELING, SIMULATION AND OPTIMIZATION

ASSESSMENT : THEORY

L	T	P	C
4	0	0	4

COURSE OBJECTIVE

- To develop the mathematical modeling for chemical separation processes and reaction kinetics by using basic fundamental laws.
- To learn about linear regression analysis in matrix form, non-linear regression and designof experiments including factorial and optimal designs.
- To provide an overview of state-of-the-art for optimization algorithms, and their use for solving several types of practically relevant optimization problems arising in chemical process.
- To introduce various non-linear operation techniques involved in the optimization of chemical separation processes.

COURSE OUTCOME

CO1: Ability to obtain mathematical model for flow processes like gravity flow tank, hydraulic transients and chemical separation processes like distillation and absorption column.

CO2: Ability to model any real system with the help of input-output data by using linear and non- linear regression analysis.

CO3: Ability to formulate and solve mathematical optimization problems for chemical reactor design and heat exchanger with and without constraints.

CO4: Ability to formulate Objective functions based on economics or functional specifications.

CO5: Ability to solve non-linear optimization problems by using various numerical techniques.

BASIC MODELING

Introduction to modeling, Application and scope of coverage, Formulation, Review of algebraic equations, Ordinary and partial differential equation. Analytical and numerical techniques, Smoothing techniques, Spline function approximations. (12)

MODELLING OF HEAT, MASS AND MOMENTUM TRANSFER OPERATIONS

Review of heat, mass and momentum transfer operations, Modeling of exchangers, Evaporators, Absorption columns, Extractors, Distillation columns, Membrane processes. (12)

MODEL DISCRIMINATION AND PARAMETER ESTIMATION

Rate equations, Linear and non-linear regression analysis, Design of experiments, Factorial, Central, fractional design, Evolutionary operation techniques, Case studies. (12)

OPTIMIZATION TECHNIQUES

Function, Analysis and numerical methods for single variable and multivariable system, constrained optimization problems. (12)

APPLICATION OF OPTIMIZATION

Heat transfer and energy conservation, Separation techniques, Fluid flow systems, Chemical Reactor design. (12)

Total : 60

TEXT BOOKS

1. *Thomas Edgar, David M. Himmelblau, Optimization of Chemical Processes, 2nd ed., McGraw Hill Book Co., New York, 2001.*

2. *William L. McCabe Luyben, Process Modeling, Simulation and Control for Chemical Engineers, 2nd ed., Tata McGraw Hill Book Co., New York, 1990.*

3. *Roger G.E. Franks, Modeling and Simulation in Chemical Engineering, Wiley-Interscience, New York, 1972.*

REFERENCES

1. *Rao S.S., Engineering Optimization - Theory and Practice, New Age International (P) Ltd., 1999.*

2. *Chemical Engineering Tutorial Numerical methods, Chemical Engineering, August 17, October 26, 1987 Feb. 15, April 25, July 18, Nov. 21, 1988, July 14, 1989.*

3. *Chemical Engineering Tutorial Statistics for Chemical Engineers, Chemical Engineering. July 23, 1985, Feb. 3, April 14, June 23, Sept. 1, 1986.*

15MPD23 PROCESS MONITORING AND FAULT DIAGNOSIS

ASSESSMENT : THEORY

L	T	P	C
4	0	0	4

COURSE OBJECTIVE

- To cite 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 present an overview of various types of fault tolerant control schemes such as Passive and active approaches.

COURSE OUTCOME

CO1: Ability to explain different approaches to Fault Detection and Diagnosis to design and detect sensor and actuators faults using structured residual approach as well as directional structured residual approach.

CO2: Ability to design and detect faults in sensor and actuators using GLR and MLR based approaches.

CO3: Ability to explain various types of fault tolerant control schemes such as Passive and active approaches.

INTRODUCTION

Introduction , Functional architecture of Process Monitoring and Diagnostic Systems, Normal and Faulty Systems and Signal Models, Residual Generation for Linear and Nonlinear Dynamic Systems, State Estimation: Observers, Kalman Filters, Extended Kalman Filters. (14)

PARAMETER ESTIMATION

Parameter Estimation: Recursive Least Squares, Instrumental Variables, Fault Detection and Diagnosis using Parameter Estimation, Influence matrix Approach, Generation of Robust, Structured an Directional Residuals, Concepts of Identifiability, Observability, Diagnosability. Fundamentals of statistical hypothesis testing, Change detection in Dynamic Systems. (12)

SIGNAL PATTERN CLASSIFICATION

Signal pattern classification: Statistical pattern classification, Artificial Neural Networks. Failure diagnosis as a classification problem, Discrete Event and Hybrid Modelling of Dynamical Systems. (12)

FAILURE DIAGNOSIS

Failure Diagnosis using DES Models: Formulation and Concept of Diagnosis. Diagnosers and Diagnosability. Introduction to Failure Diagnosis using Hybrid Systems models.

(10)

CASE STUDIES

Case Studies and Examples from Automotive, Aerospace and Industrial Systems, Application of PMFD : Fault tolerant Control of Aerospace Systems, Adaptive Supervisory Control of Industrial Processes. Overview, Review and Conclusions. (12)

Total : 60

REFERENCES

1. *S. X. Ding, "Model - based Fault Diagnosis Techniques: Design Schemes, Algorithms and Tools", Springer, 2008, ISBN : 978-3-540-76304-8*

2. *Janos J. Gertler, "Fault Detection and Diagnosis in Engineering Systems", ISBN: 0-8247-9427-3.*

3. *T. Soderstrom and Petre Stoica "System Identification", Prentice-Hall, 1989, ISBN : 978-0-138-81236-2.*

4. *C. K Chui and G. Chen, "Kalman Filtering with real -Time Applications", Springer, 1999, ISBN : 978-3-540-87848-3.*

5. *M. Basseville and A. Benvesisle, "Detection of Abrupt changes in Dynamic Systems", ISBN: 0-387-16043-4.*

6. *Ron Patton, Paul Frank and Robert Clark, "Fault Diagnosis in Dynamic Systems Theory and Applications", Prentice Hal l, 1989, ISBN : 0-L3-308263-6.*

15MCH25 PROFESSIONAL ENGINEERING PRACTICES

ASSESSMENT : PRACTICAL

L	T	P	C
0	0	2	1

COURSE OBJECTIVE

- To prepare, to a professional standard, a technical written extended abstract, having good structure and format, high standards of spelling, grammar and punctuation, and appropriate and adequate technical content.
- To plan, prepare and deliver a verbal presentation in English, to a professional standard, on their own academic work, making effective use of presentation aids, in a professional forum.
- To present, defend and debate technical information, based on their own final year project and critically analyse the work of peers and to provide constructive feedback.

COURSE OUTCOME

CO1: Able to recognize and debate the strengths and limitations of the academic component of the education of a professional engineer/surveyor.

CO2: Able to describe the need for a period of professional formation.

CO3: Able to categorize the various standards of simple Control system safety.

CONTROL SYSTEM SAFETY

Understanding Safety: Personal, Office and Industrial Safety, Understanding safety impacts on business, Compliance and its implications, Cost advantages of being safe, Why safety should not be part of Safety department only? How Safety should be made as an Inclusive culture across all functions and departments? Case studies / Videos / Spot the unsafe hazards type engagements: Conducted thro' Internal and External speakers. (5)

ETHICS

HUMAN VALUES : Morals, Values and Ethics - Integrity - Work Ethics - Services Learning - Virtues - Respect for Others - Living Peacefully - Caring - Sharing - Honesty - Courage - Valuing Time - Co-operation - Commitment - Empathy - Self Confidence - Challenges in Work Place - Cyberspace - Impact of Cyberspace on Individuals. (5)

ENGINEERING ETHICS, RESPONSIBILITIES AND RIGHTS : Senses of Engineering Ethics - Moral Issues - Inquiries - Moral Dilemma - Moral Autonomy - Profession and Responsible Professionalism - Social Responsibility - Collegiality, Loyalty and Confidentiality. (5)

ENTREPRENEURSHIP DEVELOPMENT

Entrepreneurship concept - Entrepreneurship as a Career - Entrepreneurial Personality - Characteristics of Successful Entrepreneur - Knowledge and Skills of Entrepreneur. -

Entrepreneurship Development Training and Other Support Organisational Services - Central and State Government Industrial Policies and Regulations - CASE STUDIES (5)

COST ANALYSIS

Understanding Cost analysis: Understanding process dynamic and its impact on bottomline, Showing the bigger picture, Connecting the linkage of process failures, lack of regular updations or non-following of process procedures to human and financial losses. Process audits and its advantages to bottomline, Supported by Case studies / On the spot impact on costs, gross margins discussions : Conducted thro' Internal and External speakers. (5)

INTELLECTUAL PROPERTY RIGHTS (IPR)

IPR policy of Government of India, Indian & International Patent laws, Indian Patent Act 1970;Recent Amendments, Types of patents, Patent application - forms and guidelines, feestructure, time frames, Filing of a patent application, Precautions before patenting - disclosure / non-disclosure, Patent application - forms and guidelines, feestructure, time frames, Types of patent applications: provisional and complete specifications, PCT and convention patent applications, International patenting - requirement, procedures and costs, Financial assistance for patenting - introduction to existing schemes. (5)

REFERENCES:

1. *BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007*
2. *Kankanala C., Genetic Patent Law & Strategy, 1st ed., Manupatra, Information Solution Pvt. Ltd., 2007*
3. *Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001.*
4. *S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 2001*

NOTE:

Quizzes, Seminars, presentations and test will be conducted periodically to evaluate the student performance in this subject. The students should maintain a record of their academic performance and submit the same periodically for assessment. At the end of the semester, the students must submit and present a report of their work on this subject in the standard format which will be evaluated by a team of senior faculty members and Head of the Department.

Total : 30

15MPD24 CONTROL SYSTEM DESIGN LABORATORY

ASSESSMENT : PRACTICAL

L	T	P	C
0	0	2	1

COURSE OBJECTIVE

- To provide an advanced education in control system engineering, emphasizing modern theoretical developments and their practical applications.
- To practice the fundamental principles underlying the operation of the real time control systems.
- To enable students to apply modern control principles in various areas of industry.

COURSE OUTCOME

CO1: Ability to develop the mathematical model for all sorts of physical system.

CO2: Ability to acquire a range of intellectual skills that cover the design, analysis and simulation of control systems.

CO3: Ability to demonstrate strong practical and transferable skills through laboratory exercises and the use of software packages.

LIST OF EXPERIMENTS

1. Study experiment on MATLAB for Control Systems which includes scripts, functions and flow control in MATLAB.
2. Mathematical modeling of Physical Systems.
3. Linear Time Invariant systems and Representation
4. Block diagram reduction
5. Performance of First order and Second order systems
6. DC Motor Characteristics and Validation of Dc Motor Characteristics
7. Effect of Feedback on disturbance & Control System Design
8. Effect of Feedback on disturbance & Control System design of Tank Level system
9. Open Loop and Closed Loop position control of DC servo motor
10. PID controller Design for Two Tank System
11. Simple speed Control of DC Motor
12. Stability analysis of linear systems
13. Digital Simulation of linear systems
14. State feedback controller and observer design
15. LQR problem
16. Optimal Controller Design.

Total : 30

15MPD41 PROJECT WORK AND VIVA-VOCE

ASSESSMENT : CHOCK

L	T	P	C
-	-	-	18

COURSE OBJECTIVE

The objective of this course is to introduce students to demonstrate practical concepts, command and knowledge gained so far into some realistic project.

- To produce well-groomed engineers in the areas of Process Control Engineering who will be able to make contributions in design, implementations and execution of operation and process design and control projects.
- To develop practical skills needed to understand and modify any problems related to process design and implementation.
- To develop skills among chemical engineering professionals by which they can perform a variety of functions that ranges from installing applications to designing complex process.
- To provide an exposure to prominent cutting edge technologies, sufficient training & opportunities to work as teams on multidisciplinary projects with effective writing and communication skills.

COURSE OUTCOME

The above exercise shall make the students competent in the following ways and will be able to learn following parameters at the end of the course.

CO1: Students should be able to design, analyse the data and interpretation of a chemical process system to meet desired needs.

CO2: Students are provided to work multidisciplinary areas related to Process Control engineering.

CO3: Students should be able to work as Process Control Engineering Professionals, with portfolio ranging from process, data analysis, perform data management and software design, as well as management and administration of entire systems.

Every candidate individually shall undertake the project work during the fourth semester. Work can be undertaken in an industrial/research organization or in the Institute in consultation with the faculty guide and the Head of the department. In case of Project Work at industrial/research organization, the same shall be jointly supervised by a faculty guide and an expert from the organization. The students should maintain a record of the work done regularly and submit them for assessment periodically. At the end of the semester, the students should submit a report of the work done in standard format which will be evaluated by the faculty and subject experts.

15MPDE01 PROCESS FLOW SHEETING AND P&I DIAGRAM

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- The major objective is to understand how to invent chemical process flowsheets, how to generate and develop process alternatives, and how to evaluate and screen them quickly.
- To simulate the steady-state behavior of process flowsheets using a suitable simulation software.
- To identify ISA symbols and interpret basic flow sheet layout principles.

COURSE OUTCOME

CO1: Able to draw the input/output structure of a flow sheet for a given manufacturing unit.

CO2: Able to Synthesize and design flow sheet sub-systems, to develop the recycle structure(s).

CO3: Able to simulate the steady-state behavior of process flow sheets at each level of process development.

FLOWSHEETING

Introduction, Symbols, Flow sheet presentation with examples, Manual flow sheet calculation, Constrains and their applications in flow sheet calculations, Types of flow sheets, Synthesis of steady state flow sheet, Flow sheeting software. (9)

SEQUENTIAL MODULAR APPROACH TO FLOWSHEETING

Solution, partitioning and tearing a flow sheet, convergence of tear streams with suitable example. (9)

FLOWSHEETING BY EQUATION SOLVING METHODS

Selection, decision and tearing of variables in a flow sheet with simple and complex examples. (9)

FLOWSHEET APPLICATIONS

P & I D development, typical stages of P & I D, Applications of P & I D in design stage - Construction stage - Commissioning stage - Operating stage - Revamping stage - Applications of P & I D in HAZOPS and Risk analysis. (9)

FLOWSHEET OPTIMIZATION AND P&ID

Flow sheet with recycle, Flow sheet optimization, The P& I Diagram, Basic Symbols and Layout, General Instruments and Controller symbols, Type of Instruments, Valves and Selection of Valves, Pumps and Compressor and Selection of Pumps and Compressors. (9)

Total : 45

TEXT BOOKS

1. *Ernest E. Ludwig, "Applied Process Design for Chemical and Petrochemical Plants", Vol-I Gulf Publishing Company, Houston, 1989.*

2. *Max. S. Peters and K.D.Timmerhaus, "Plant Design and Economics for Chemical Engineers", McGraw Hill, Inc., New York, 1991.*

3. *Gawin Towler, Ray Sinnott, "Chemical Engineering Design" Elsevier, 2008.*

REFERENCES

1. *Anil Kumar, "Chemical Process Synthesis and Engineering Design", Tata McGraw Hill publishing Company Limited, New Delhi - 1981.*

2. *A.N. Westerberg, et al., "Process Flowsheeting", Cambridge University Press, 1979.*

3. *Paul Benedek, "Steady state Flowsheeting of Chemical Plants", Elsevier Scientific Publishing company,1980.*

15MPDE02 NONLINEAR CONTROL SYSTEMS

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To provide a solid background to the students in the design analysis and of nonlinear control systems.
- To provide an introduction to nonlinear deterministic dynamic systems, and applications to nonlinear circuits and control systems.
- To manipulate non-linear transformations and to distill mapping properties.

COURSE OUTCOME

CO1: The student should be able to appreciate that many control systems of practical importance are inherently nonlinear.

CO2: The student should have been equipped with necessary analytical and computational tools to analyze nonlinear systems and design suitable controllers.

CO3: The student should able to develop more knowledge on Industrial Process Control.

INTRODUCTION TO NONLINEAR SYSTEM

Classification of non-linearity, types of non-linearity in physical system, jump phenomena and critical jump resonance curve, methods of analysis of non-linear systems and comparison, linearization, slope, isoclines, singular point, limit cycle. (9)

PHASE PLANE ANALYSIS

Concept of phase plane, phase trajectory, phase portraits, methods of plotting phase plane trajectories Vander Pol's equation, stability from phase portrait, time response from trajectories, isoclines method, Pell's method of phase trajectory, Delta method of phase trajectory construction. (9)

STABILITY CRITERION

Linear systems, linearization of nonlinear systems about equilibrium point, Liapunov's indirect method, Stability analysis of nonlinear system using Liapunov's theorem, Nonlinear Control Design: Feedback linearization, Input Output linearization, sliding mode. (9)

VARIABLES STRUCTURE CONTROL

Sliding Control: Sliding surfaces, continuous approximations of switching control laws, modeling performance tradeoffs, VSSC - examples. (9)

FREQUENCY DOMAIN ANALYSIS

Absolute stability, circle criterion, Popov criterion, Describing function (DF) of typical nonlinearities stability analysis using DF method, DIDF, pole zero shifting transformation.

(9)

Total : 45

REFERENCES

1. *R. Marino and P. Tomei Nonlinear control design - Geometric, Adaptive and Robust, Prentice Hall,1995.*
2. *J.J.E.Slotine and W.Li Applied Nonlinear control, Prentice Hall, 1998.*
3. *Alberto Isidori Non linear Control systems, Springer Verlag, 1999.*

15MPDE03 EMBEDDED CONTROL SYSTEMS

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To develop the fundamental knowledge on embedded system hardware organization.
- To learn the methods of designing and interfacing embedded systems.
- To understand the basics of real time operating system and to learn the design methodologies and hardware and software interface.

COURSE OUTCOME

CO1: By this the student is aware of the embedded system hardware organization, it also helps in designing and interfacing embedded systems.

CO2: The student is able to understand the basics of real time operating system and basics of exemplary RTOS.

CO3: Ability to understand the concepts of Real Time Models, languages, Real Time Kernels principles and standards.

EMBEDDED SYSTEM ORGANIZATION

Embedded computing - characteristics of embedded computing applications - embedded system design challenges - Build process of Real time Embedded system - Selection of processor, Memory, I/O devices - Rs-485, MODEM, Bus Communication system using I2C, CAN, USB buses, 8 bit - ISA, ESIA bus (9)

REAL - TIME OPERATING SYSTEM

Introduction to RTOS, RTOS - Inter Process communication, Interrupt driven Input and Output - Nonmaskable interrupt, Software interrupt, Thread - Single, Multithread concept, Multitasking Semaphores. (9)

INTERFACE WITH COMMUNICATION PROTOCOL

Design methodologies and tools - Design flows - designing hardware and software Interface - System integration - SPI - High speed data acquisition and interface - SPI read/write protocol, RTC interfacing and programming. . (9)

DESIGN FOR SOFTWARE FOR EMBEDDED CONTROL

Software abstraction using Mealy - Moore FSM controller, Layered software development, Basic concepts of developing device driver - SCI - Software - Interfacing & porting using standard C & C++, Functional and performance Debugging with benchmarking Realtime system software - Survey on basics of contemporary RTOS - VXWorks, UC/OS-II. (9)

CASE STUDIES WITH EMBEDDED CONTROLLER

Programmable interface with A/D & D/A interface, Digital voltmeter, control - Robot system - PWM motor speed controller, serial communication interface (9)

Total: 45

TEXT BOOKS

1. *F. Vahid and T.D.Givargis:Embedded System Design : A unified hardware/software introduction, John Wiley & Sons, 2002.*

2. *Keshab K. Parhi:VLSI Digital Signal Processing Systems : Design and Implementation, John Wiley & Sons, 2003.*

3. *Tim Wescott:Applied Control Theory for embedded systems, Newness Publications, 2006.*

REFERENCES

1. *Steven F.Barrett, Daniel J.Pack, "Embedded Systems-Design & Application with the 68HC12 & HCS12", Pearson Education,2008.*

2. *Daniel W. Lewis, "Fundamentals of Embedded Software", Prentice Hall India, 2004.*

3. *Jack R Smith "Programming the PIC microcontroller with MBasic" Elsevier, 2007.*

4. *Keneth J.Ayala, "The 8086 Microprocessor: Programming & Interfacing the PC", Thomson India edition, 2007.*

15MPDE04 NEURAL NETWORK AND FUZZY SYSTEMS

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To cater the knowledge of Neural Networks and Fuzzy Logic Control and use these for controlling real time systems.
- To develop the motivation to design of intelligent systems & Control.
- To provide the exposure to Computer simulations, Algorithms and Design of many real world problems.

COURSE OUTCOME

CO1: Ability to explain the principles of neural networks and fuzzy logic fundamentals and to design the required and related systems.

CO2: To acquire understanding and knowledge of soft computing models and algorithms and so they will be able to design program systems using these techniques to solve various real-world problems.

CO3: Ability to appreciate the importance of tolerance of imprecision and uncertainty for design of robust and low cost intelligent systems. Apply these techniques in engineering case studies, including robotics, traffic light systems etc.,

INTRODUCTION TO NEURAL NETWORKS

Artificial Neural Networks: Basic properties of Neurons, Neuron Models, Feed forward networks - Perceptrons, Widrow - Hoff LMS algorithm, Multilayer networks - Exact and approximate representation, Back propagation algorithm, variants of Back propagation, Unsupervised and Reinforcement learning, Symmetric Hopfield networks and Associative memory, Competitive learning and self - organizing networks, Hybrid Learning, Computational complexity of ANNs. (9)

NEURAL NETWORK BASED CONTROL

ANN based control: Introduction - Representation and identification, modeling the plant, control structures - supervised control, Model reference control, Internal model control, Predictive control: Examples - Inferential estimation of viscosity an chemical process, Auto - turning feedback control, industrial distillation tower. (9)

INTRODUCTION TO FUZZY LOGIC

Fuzzy Controllers: Preliminaries - Fuzzy sets and Basic notions - Fuzzy relation calculations - Fuzzy members - Indices of Fuzziness - comparison of Fuzzy quantities - Methods of determination of membership functions. (9)

FUZZY LOGIC BASED CONTROL

Fuzzy Controllers: Preliminaries - Fuzzy sets in commercial products - basic construction of fuzzy controller - Analysis of static properties of fuzzy controller - Analysis of dynamic properties of fuzzy controller - simulation studies - case studies - fuzzy control for smart cars. (9)

NEURO - FUZZY AND FUZZY - NEURAL CONTROLLERS

Neuro - fuzzy systems - A unified approximate reasoning approach - Construction of role bases by self learning - System structure and learning algorithm - A hybrid neural network based Fuzzy controller with self learning teacher, Fuzzified CMAC and RBF network based self-learning controllers. (9)

Total: 45

REFERENCES

1. *Laurene V. Fausett, "Fundamentals of Neural Networks, Algorithms and Applications", Prentice Hall, 1994.*

2. *Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley International, 3rd ed., 2010.*

3. *Kosco B, "Neural Networks and Fuzzy Systems: A Dynamic Approach to Machine Intelligence", Prentice Hall of India, New Delhi, 1992.*

4. *George J. Klir and Folger T.A, "Fuzzy sets, Uncertainty and Information", Prentice Hall of India, New Delhi, 2000.*

15MPDE05 MULTIVARIABLE CONTROL SYSTEMS

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To appreciate the analysis of multivariable systems.
- To apply the knowledge in control of multivariable systems.
- To analyze different application and case studies.

COURSE OUTCOME

CO1: Ability to describe the importance of multivariable control concepts and analyze the non linearity in real time control situations.

CO2: Ability to develop the familiarity with transfer matrix and state variable models for linear multivariable systems, including the concepts of poles, zeros, controllability, observability, detectability, stabilizability and minimality.

CO3: Ability to perform the analysis of H1,H2 and features.

MULIVARIABLE 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. (9)

MULTI-LOOP REGULATORY CONTROL

Multi-loop control - Introduction - Process Interaction - Pairing of Inputs and Outputs - The Relative Gain Array RGA - Properties and Applications of RGA - Multi - loop PID Controller - Biggest Log Modulus Tuning Method - Decoupling Control - LQG Control - RGA for Non - square Plant. (9)

MULIVARIABLE REGULATORY CONTROL

Introduction to Multivariable control - Multivariable PID Controller - Multivariable IMC - Multivariable Dynamic Matrix Controller - Multivariable Model Predictive Control - Generalized Predictive Controller - Multiple Model based Predictive Controller - Constrained Model Predictive Controller - Implementation Issues. (9)

ANALYSIS OF THE RICCATI EQUATION

Compare to Lyapunov equation - the Hamiltonian matrix - stabilizing solutions - frequency domain properties of LQR - the Nyquist test - gain and phase margins - Passivity - Positivity - Self - Dual realizations - and collocation. (9)

LINEAR QUADRATIC GAUSSIAN (LQG) CONTROLLER SYNTHESIS

Closed loop properties - H2 performance, observers and the Kalman filter - frequency domain performance specifications - reduced order LQG H1 Analysis and Synthesis - H1 norm for SISO and MIMO cases - nominal performance - robust stability - mixed sensitivity - H2 / H1 with cross - weighting - loop - shaping. (9)

Total : 45

TEXT BOOKS

1. *B.D.O. Anderson and J.B. Moore, Optimal Control: Linear Quadratic Methods, Prentice-Hall,1990.*
2. *S.P. Boyd, Control System Design - Limits to Performance, Prentice-Hall, 1990.*
3. *W. Brogan, Modern Control Theory, 3rd ed., Prentice-Hall, 1991.*
4. *A.E. Bryson, Jr., Dynamic Optimization, Addison-Wesley, 1991.*
5. *J.B. Burl, Linear Optimal Control: H2 and H1 Methods, Longman, 1998.*
6. *C-T Chen, Linear System Theory and Design, 3rd ed., Oxford University Press, 1998.*

REFERENCES

1. *Coughanowr D.R., "Process Systems Analysis and Control", McGraw Hill International edition, 2004.*
2. *Ikonen E. and Najim K, "Advanced Process Identification and Control", Marcel Dekker, 2002.*

15MPDE06 NONLINEAR OSCILLATION

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To give a compact, consistent, and reasonably connected account of the theory of nonlinear vibrations at the advanced level.
- To explain how the state space dimension limits the possible dynamics.
- To sketch the limit set and starting from this characterize the main features in the flow of a dynamical system given by ODEs in the plane.

COURSE OUTCOME

CO1: Ability to analyze and calculate the fractal dimension in a few simple cases.

CO2: Ability to strengthen the concept of chaos in dynamical systems and state some properties of a chaotic dynamical system.

CO3: Ability to recognize and describe the result of a simulation using the concept of Poincare mapping.

INTRODUCTION

Linear and nonlinear systems, conservative and non-conservative systems, potential well, Phase planes, types of forces and responses, fixed points, periodic, quasi-periodic and chaotic responses, Local and global stability, commonly observed nonlinear phenomena, multiple response, bifurcations, jump phenomena. (9)

DEVELOPMENT OF NONLINEAR GOVERNING EQUATION OF MOTION

Mechanical systems, linearization techniques, ordering techniques, commonly used nonlinear equations, Duffing equation, Van der Pol's oscillator, Mathieu's and Hill's equations. (9)

ANALYTICAL SOLUTION METHODS

Harmonic balance, perturbation techniques (Linstedt - Poincare', method of Multiple Scales, Averaging - Krylov - Bogoliubov - Mitropolsky), incremental harmonic balance, modified Lindstedt Poincare' techniques. (9)

STABILITY AND BIFURCATION ANALYSIS

Static and dynamic bifurcations of fixed point and periodic response, different routes to chaotic response (period doubling, torus break down, attractor merging etc.), crisis. (9)

NUMERICAL TECHNIQUES

Time response, phase portrait, FFT, Poincare' maps, point attractors, limit cycles and their numerical computation, strange attractors and chaos, Lyapunov exponents and their determination, basin of attraction, point to point mapping and cell to cell mapping, fractal dimension, Application, Single degree of freedom systems, Free vibration - Duffing's oscillator, primary - secondary - and multiple - resonances, Forced oscillations, Van der Pol's oscillator, parametric excitation, Mathieu's and Hill's equations, Floquet theory, effects of damping and nonlinearity, Multi degree of freedom and continuous systems. (9)

Total : 45

REFERENCES

1. *Nayfeh, A.H. and Mook, D.T.Nonlinear Oscillations, Wiley-Interscience, 1979.*
2. *Hayashi, C. Nonlinear Oscillations in Physical Systems, McGraw-Hill, 1964.*
3. *EvanIvanowski, R.M. Resonance Oscillations in Mechanical Systems, Elsevier, 1976.*
4. *Nayfeh, A.H. and Balachandran, B., Applied Nonlinear Dynamics, Wiley, 1995.*
5. *Seydel, R., From Equilibrium to Chaos : Practical Bifurcation and Stability Analysis, Elsevier, 1988.*
6. *Moon, F.C., Chaotic & Fractal Dynamics : An Introduction for Applied Scientists and Engineers, Wiley, 1992.*
7. *Rao,J.S., Advanced Theory of Vibration: Nonlinear Vibration and One-dimensional Structures, New Age International, 1992.*

15MPDE07 ROBUST AND OPTIMAL CONTROL

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To provide a basic knowledge of the theoretical foundations of optimal control.
- To develop the skill needed to design controllers using available optimal control theory and software.
- To introduce current research in optimization methods for robust control.

COURSE OUTCOME

CO1: Ability to design and implement system identification experiments.

CO2: Ability to use singular value techniques to analyze the robustness of control systems and incorporate frequency-domain-based robustness specifications into multivariable control system designs.

CO3: Ability to use H-infinity methods to design robust controllers.

INTRODUCTION

Norms for signals and systems, Input - Output Relationships, Internal stability, Asymptotic Tracking, Performance, Uncertainty and Robustness, Plant Uncertainty, Robust stability, Robust performance. (9)

STABILIZATION

Controller parameterization for stable plant, Co-prime factorization, controller parameterization for general plant, Asymptotic properties, strong and simultaneous stabilization, Design Constraints, Algebraic constraints, Analytic constraints, Design for Performance, P-1 stable, P-1 unstable, Design example, 2-norm Minimization. (9)

STABILITY MARGIN OPTIMIZATION

Optimal Robust stability, Gain margin Optimization, Phase margin optimization, Design for Robust Performance : The modified problem, spectral factorization, solution of the modified problem, design, Optimal Feedback Control, Formulation of optimal control problem, selection of performance criteria for minimum time, minimum energy, Minimum fuel, Principle of optimality, Hamilton - Jacobi - Bellman equation, State regulator, output regulator and tracking problems. (9)

H^∞ CONTROL

H^∞ Control: A brief history, Notation and terminology, The two - port formulation of control problems, H^∞ control problem formulation and assumptions, Problem solution, Weights in H^∞ control problems, Design example. (9)

CALCULUS OF VARIATIONS

Fundamental concepts, minimization of functions, minimization of functionals, functional of a single function, functionals involving several independent functions, Piecewise smooth extremals, constrained extremal, Pontryagins minimum principles, control and state variable inequality constraint, Dynamic Programming, Multi stage decision process in discrete time, principle of causality and optimality, Multi stage decision process in continuous time, Numerical solution of two-point boundary value problem, Minimization of functions, The steepest decent method, The Fletcher-Powell method. (9)

Total : 45

REFERENCES

1. *J.C. Doyle, B.A. Francis and A .R. Tannenbaum, Feedback control Theory, Macmillan publishing company, New York. 1992.*

2. *K.Morris, Introduction to feedback control, Academic press. 2001.*

3. *B.A Francis, A course in* H^{∞} *control theory, Lecture notes in control and Information sciences, Springer-Verlag, 1987*

4. *K. Ogata, Discrete time control systems, Prentice Hall. 1987.*

15MPDE08 PILOT PLANTS, MODELS AND SCALE UP METHODS

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To learn how to create and conduct a pilot plant study, analyze and evaluate pilot plant results, and apply process scale-up methods.
- To study proper designs, modelling and processing and the importance of the process geometry.
- To provide the different concepts of scale-up in mixing and contacting.

COURSE OUTCOME

CO1: Ability to underline the techniques to solve problems relevant to the general practice of chemical engineering and engineering design.

CO2: Ability to provide the experience in the process of original chemical engineering design in the three areas of equipment design, process design, and plant design through the process of formulating a design solution to a perceived need and then executing the design and evaluating its performance including economic considerations and societal impacts.

CO3: Ability to identify the effects of scale on the relative rates of mass, heat and momentum transfer, mixing effects, utility of various reactor operating modes and the acquisition of reliable kinetic, thermodynamic and transport data.

PRINCIPLES OF SIMILARITY, PILOT PLANTS & MODELS

Introduction to scale up methods, pilot plants and models and principles of similarity. (9)

DIMENSIONAL ANALYSIS AND SCALE - UP CRITERION

Dimensional Analysis, Regime concept, similarity criterion and scale up methods used in chemical engineering. (10)

SCALE - UP OF MIXING AND HEAT TRANSFER EQUIPMENT

Typical problems in scale - up of mixing equipment and heat transfer equipment. (9)

SCALE - UP OF CHEMICAL REACTORS

Kinetics, Reactor Development & scale - up techniques for chemical reactors. (9)

SCALE - UP OF DISTILLATION COLUMN & PACKED TOWERS

Scale - up of distillation columns and packed towers for continuous and batch process. (8)

Total: 45

REFERENCES

1. *John stone and Thring, "Pilot plants models and scale - up methods in chemical Engineering", McGraw - Hill, New York, 1962.*

2. *Marko Zlokarnik, "Dimensional Analysis and scale - up in Chemical Engineering", Springer - Verlag, Berlin, Germany, 1986.*

3. *Donald. G. Jordan." Chemical Process Development: (Part 1 & 2), Interscience Publishers, 1988.*

15MPDE09 PROBABILITY AND COMPUTING

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OUTCOME

- To cite basic concepts and tools in probability theory that are relevant to computing, including random variables, independence, moments and deviations, tail inequalities, occupancy problems, the probabilistic method, derandomisation and Markov chains.
- To use the above tools to devise and analyse randomized algorithms and carry out the probabilistic analysis of deterministic algorithms.
- To examine some of the main paradigms in the design of randomized algorithms, including random sampling, random walks, random rounding, algebraic techniques, foiling the adversary and amplification.

COURSE OUTCOME

CO1: Ability to discuss applications of probabilistic techniques to computer science, focusing on randomized algorithms and the probabilistic analysis of algorithms.

CO2: Ability to apply randomization and probabilistic techniques in communication protocols, combinatorial optimization, computational geometry, data structures, networks and machine learning.

CO3: Ability to apply those ideas in probability to certain situations that are most relevant to computer science.

LINEAR ALGEBRA

Matrices and systems of linear equations. Vector spaces over general fields, subspaces, linear independence, basis, dimension. Determinants. Linear transformations, associated matrices, change of basis, dimension formula. Dual vector spaces. Eigen values, eigen spaces, diagonalization, Jordan canonical form. Inner product spaces, bilinear, quadratic and hermitian forms. Adjoint, self-adjoint, orthogonal and unitary operators. Diagonalization in Euclidean and unitary spaces. The spectral theorem. (9)

REAL ANALYSIS

Sequences of functions: pointwise and uniform convergence, continuity and convergence, interchange of limit with derivatives and integrals, Arzela - Ascoli theorem, Weierstrass and Stone-Weierstrass approximation theorems. Differentiation of integrals with parameters. Infinite series: series of numbers and functions, absolute convergence, power series. Elementary functions, rigorous introduction of the exponential, logarithmic, trigonometric and inverse trigonometric functions. Functions of several variables: the derivative as a linear transformation, Taylor's theorem, the inverse and implicit function theorems. (9)

COMPLEX VARIABLES

Analytic functions, Cauchy-Riemann equations, entire functions, the exponential, trigonometric, and logarithmic functions, Euler's formula. Line integrals, Cauchy's theorem, Cauchy's integral formula, power series representation and consequences, uniqueness theorem, mean value theorem, maximum modulus principle, open mapping theorem. Morera's theorem, Liouville's theorem and applications, meromorphic functions, Laurent expansions, residue theorem and applications, fractional linear transformations. (9)

BASIC PROPERTY

Basic Concepts: random variables, mass and density functions, combinational analysis, conditional probability, Bayes' formula, independence.

Expectation: moments, generating functions (moment, probability, factorial), characteristic function, Markov's inequality, Chebyshev's inequality, conditional expectation, independence, correlation. Special distributions and their generating functions: binomial, negative binomial, Poisson, hypergeometric, multinomial, gamma, sums of independent gamma variables, beta, relationships between gamma and beta, normal, linear combinations of normal variables, exponential, Cauchy, Raleigh, Weibull, extreme value. Functions of random variables and transformation's. Limit theorems: types of convergence (almost sure, in probability, in distribution, Lp), continuity theorem, central limit theorem, law of large numbers. (9)

BASIC STATISTICS

Sampling distributions: independent random sampling, Chi-square, t and F distributions, order statistics, independence between X-bar and S2, noncentral Chi-square, t and F. Multivariate normal distribution: properties, moments generating function, marginal and conditional densities, Cocharan's theorem. Methods of estimation: moments, least-squares, likelihood function and inference: large sample properties of MLEs. Likelihood ratio statistic. Hypothesis testing - Neyman - Pearson fundamental lemma, uniformly most powerful tests, likelihood ratio test. Nonparametric inference - Kolmogorov-Smirnoff, Pearson chi-square, contingency tables, Wilcoxon and permutation tests. Bayesian inference:prior and posterior distributions, Bayesian intervals, improper priors. (9)

Total: 45

REFERENCES

1. *"Introduction to Mathematical Statistics" by Robert V. Hogg and Allen T. Craig, 5th ed., Macmillan, New York, 1995.*

2. *"Statistical Inference" by S.D. Silvey, Chapman & Hall, London, 1991.*

3. *"A First Course in Probability" by Sheldon Ross, 6th ed., Prentice-Hall, Upper Saddle River, 2002.*

4. *R. Greene and S. Krantz "Function Theory of One Complex Variable", 2006.*

5. *Marsden and Tromba "Vector Calculus", 2007.*

6. *Walter Rudin "Principles of Mathematical Analysis",*

7. *J. Marsden and M. Hoffman "Elementary Classical Analysis", 1993.*

8. *Schaum's Outlines: Linear Algebra: Chapters 1-13, 5th ed., 2012*

15MPDE10 PROJECT ENGINEERING OF PROCESS PLANTS

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To introduce basic knowledge of project management techniques and evaluation of projects in chemical engineering field.
- To teach the industrial safety and legal aspects of business encounter in process industries.
- To learn the safety in equipment and machinery operations.

COURSE OUTCOME

CO1: Ability to discuss project engineering management, techniques, and the concepts in chemical industry.

CO2: Ability to evaluate engineering projects, modification in the process and balancing the process to current economic status.

CO3: Ability to do feasibility analysis of the process, cash flow analysis and marketing the product.

IDENTIFICATION OF PROJECTS

Project definition, Project Profile and standards, Feedback information (MIS) Evaluation and modification, Selection. (8)

PROJECT ENGINEERING

Planning the process, strategic and managerial planning, Organising the process planning, costs and costing, Cost control systems, Economic balancing, Network planning methods (PERT/CPM), Engineering flow diagrams, cost requirements, analysis and estimation of Process feasibility (Technical/Economical) analysis, Cost - Benefit ratio analysis, Project budgeting, Capital requirements, capital market, Cash flow analysis, Break even strategies. (10)

ENGINEERING MANAGEMENT

Plant engineering Management, Objectives, Programme, control, plant location and site selection, Layout diagrams, Selection and procurement of equipment and machineries, Installation, Recommissions, Commissioning of safety organization and control, Pollution and Pollution control and abatement, Industrial safety standard analysis. (10)

INDUSTRIAL SAFETY

Process safety, Material safety and handling regulations, Safety in equipment and machinery operations, design considerations of safety organization and control, Pollution and Pollution control and abatement, Industrial safety standard analysis. (9)

LEGAL ASPECTS OF BUSINESS ENTERPRISES

Government regulations on procurement of raw materials and its allocation, Export - Import regulations, Pricing policy, Industrial licensing procedure, Excise and other commercial taxes, Policies on depreciation and corporate tax, Labour laws, Social welfare legal measurements, Factory act, Regulations of Pollution Control Board. (8)

Total: 45

REFERENCES

1. *Perry, J. H. "Chemical Engineer's Hand Book", 8th ed., McGraw Hill, New York, 2007.*
2. *Max S Peters and Klaus D Timmerhaus, "Plant Design and Economics for chemical Engineers", 4th ed., McGraw-Hill,New York,1990.*
3. *Aries and Newton - "Chemical Engineering cost Estimation", McGraw-Hill, New York, 1965.*
4. *John Happel and D.A. Jordan "Chemical Process Economics", Marcell Dekker Incorporation, USA, 1977.*
5. *Lewis - " Management Handbook for Plant Engineers ", McGraw-Hill, 1977.*
6. *"Handbook of Industrial Safety and Health ", Trade and Technical Press Ltd., England, 1980.*
7. *Kharbanda, O.P. - "Process Plant and Equipment cost estimation ", Sevak Publications, Bombay, 1977.*

15MPDE11 SOFT COMPUTING TECHNIQUES

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To expose the concepts of feed forward neural networks.
- To provide adequate knowledge about feedback neural networks and to teach about the concept of fuzziness involved in various systems.
- To expose the ideas about genetic algorithm and to provide adequate knowledge about of FLC and NN toolbox.

COURSE OUTCOME

CO1: Ability to acquaint the students with soft computing methodologies.

CO2: Ability to demonstrate knowledge on Neural networks, fuzzy logic, genetic algorithms and hybrid algorithms.

CO3: Ability to implement soft computing techniques in real time intelligent and adaptive systems.

NEURAL NETWORKS

Supervised Learning Neural Networks: Perceptron - Adaline - Back propagation Multilayer Perceptrons - Radial Basis Function Networks - Unsupervised Learning Neural Networks: Competitive Learning Networks - Kohonen Self-Organizing Networks - Learning Vector Quantization. (9)

FUZZY LOGIC

Introduction - Fuzzy sets - Basic Definition and Terminology - Set-theoretic Operations - Member Function Formulation and Parameterization - Fuzzy Rules and Fuzzy Reasoning - Extension Principle and Fuzzy Relations - Fuzzy If-Then Rules - Fuzzy Reasoning - Fuzzy Inference Systems - Mamdani Fuzzy Models - Sugeno Fuzzy Models - Tsukamoto Fuzzy Modes - Input Space Partitioning and Fuzzy Modeling. (9)

EVOLUTIONARY COMPUTING

Introduction - Problem solving as a search task - Hill Climbing and Simulated Annealing - Evolutionary computing: Standard Evolutionary Algorithm - Genetic Algorithms - Roulette wheel selection - Crossover - Mutation - Other main Evolutionary Algorithms: Evolution Strategies - Evolutionary Programming - Genetic Programming - Scope of Evolutionary computing. (9)

NATURAL COMPUTATION

Introduction - ANT Colonies: ANT Optimization (ACO) - ANT Clustering Algorithm(ACA) - Social Adaptation of Knowledge : Particle Swarm Optimization (PSO) - Artificial Bee Colony Optimization(ABC). (9)

APPLICATIONS

Applications of Neural network in Pattern Recognition - Applications of Fuzzy logic in Air Conditioner Controller - Application using Hill Climbing and Simulated Annealing Techniques - Optimization of Neural Network Weights using Particle Swarm Optimization. (9)

Total : 45

REFERENCES

1. *J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, 2004, Pearson Education, 2004.*
2. *N.P.Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2006.*
3. *Elaine Rich & Kevin Knight, Artificial Intelligence, Second Edition, Tata McGraw Hill Publishing Comp., 2006, NewDelhi.*
4. *Timothy J.Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, 1997.*
5. *Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.*
6. *S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2000.*
7. *R.Eberhart, P.Simpson and R.Dobbins, "Computational Intelligence - PC Tools", AP Professional, Boston, 1996.*
8. *Amit Konar, "Artificial Intelligence and Soft Computing Behaviour and Cognitive model of the human brain", CRC Press, 2008.*

15MPDE12 SYNCHRONIZATION AND ITS RECENT APPLICATIONS IN CHAOTIC SYSTEMS

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To provides a introduction to nonlinear dynamics of dissipative systems.
- To focus on simple dynamical models that exhibit reach nonlinear phenomena.
- To predict the nonlinear dynamics using both analytical and numerical methods.

COURSE OUTCOME

CO1: Ability to demonstrate the nonlinear dynamics of dissipative systems.

CO2: Ability to explain the concept of synchronization in non linear adaptive systems.

CO3: Ability to analyze the chaotic system in practical applications.

INTRODUCTION, PHASE SPACE, AND PHASE PORTRAITS

Linear systems and their classification - Existence and uniqueness of solutions - Fixed points and linearization - Stability of equilibria - Pendulum and Duffing oscillator, Lindstedt's method - Conservative and reversible systems. (9)

LIMIT CYCLES

The van der Pol oscillator - Method of Averaging - Relaxation oscillators - Weakly nonlinear oscillator - Forced Duffing oscillator - Method of Multiple Scales - Forced van der Pol oscillator - Entrainment - Mathieu's equation - Floquet Theory - Harmonic Balance. (9)

BIFURCATIONS

Saddle-node - transcritical - and pitchfork bifurcations - Center manifold theory - Hopf bifurcation - Global bifurcations - and Poincaré maps. (9)

NONLINEAR NORMAL MODES

Nonlinear Normal Mode manifolds of multi-degree-of-freedom systems - external and internal resonances - and Energy transfer through nonlinear interactions. (9)

CHAOTIC DYNAMICS

Lorentz equations - Lorentz map - Logistics map - Lyapunov Exponents - fractal sets and their dimensions - box, pointwise and correlation dimensions - strange attractors - and forced two-well oscillator. (9)

Total: 45

REFERENCES

1. *Richard H. Rand, Lecture Notes on Nonlinear Vibrations, version 52, 2005.*

2. *S.H. Strogatz, Nonlinear Dynamics and Chaos with Applications to Physics, Biology, Chemistry and Engineering, Perseus Books Publishing, 2000.*

3. *J.C. Sprott, Chaos and Time-Series Analysis, Oxford University Press, 2003.*

4. *G.L. Baker and J.P. Gollub, Chaotic Dynamics, 2nd ed., Cambridge University Press, New York, 1996.*

5. *Edward Ott, Chaos in Dynamical Systems, Cambridge, 1993.*

6. *K.T. Alligood, T.D. Sauer, and J.A. Yorke, CHAOS - An Introduction to Dynamical Systems, Springer, 1996.*

7. *D. Kaplan and L. Glass, Understanding nonlinear dynamics, Springer-Verlag, New York, 1995.*

8. *J.M.T. Thompson and H.B. Stewart, Nonlinear dynamics and chaos, John Wiley and Sons, New York, 1986.*

15MPDE13 EMBEDDED SENSORS NETWORKS

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE EDUCATIONAL OBJECTIVES

- To explore the design space and conduct trade-off analysis between performance and resources.
- To assess coverage and conduct node deployment planning.
- To devise appropriate data dissemination protocols and model links cost.

COURSE OUTCOMES

CO1: Ability to analyze a broad coverage of challenges and latest research results related to the design and management of wireless sensor networks.

CO2: Ability to synthesize topics includes network architectures, node discovery and localization, deployment strategies, node coverage, routing protocols, medium access arbitration, fault-tolerance, and network security.

CO3: Ability to identify the latest sensors and also the applications.

INTRODUCTION

Overview of sensor networks - Constraints and Challenges - Advantages of sensor networks - Sensor Network Applications - Collaborative Processing - Key definitions in sensor networks - Tracking scenario - Problem formulation - Sensing model - Collaborative Localization - Bayesian Estimation - Distributed representation and interference of states - Tracking multiple objects - State Space Decomposition Data Association - Sensor models - performance comparison and metrics. (9)

NETWORKING SENSORS

Key assumptions - Medium access control - A survey of MAC protocols for WSN - S-MAC Protocol - IEEE 802.15.4 standard and ZigBee - Energy efficient design of wireless sensor nodes - General Issues - Geographic, Energy - Aware Routing - Unicast Geographic Routing - Routing on a curve - Energy Minimizing Broadcast - Energy Aware Routing to a Region - Attribute based routing - Directed Diffusion - RumorRouting - Geographic Hash Table. (9)

INFRASTRUCTURE ESTABLISHMENT

Topology control - Clustering-Time synchronization - Clocks and Communication Delays - Interval Methods - Reference Broadcasts - Localization and Localization Services - RangingTechniques - Range Based Localization Algorithms - Location Services - Task Driven sensing - Role of sensor nodes and Utilities - Information based Sensor Tasking - Sensor Selection - IDSQ - Cluster leader based Protocol - Sensor tasking in tracking relations -

Joint Routing and Information aggregation - Moving Centre of Aggregation - Multistep Information aggregation - Moving Centre of Aggregation - Multistep Information Aggregation - Multistep Information Directed Routing - Sensor Group Management. (9)

SENSOR NETWORK DATABASE

Sensor Database Challenges - Querying the physical environment - Query Interfaces - Cougar Sensor Database - Probabilistic Queries - In-network aggregation - Query Propagation and Aggregation - Tiny DB Query Processing - Query processing Scheduling and Optimization - Data centric storage - Data indices and range queries - Distributed Hierarchical aggregation - Multi resolution Summarization - Partitioning the summaries - Fractional Cascading - Locality Preserving Hashing - Temporal data - Data Aging - Indexing Motion Data. (9)

SENSOR NETWORK PLATFORMS AND TOOLS

Sensor Node Hardware - Sensor network programming challenges - Node level software platforms - Operating system Tiny OS - Node level simulators - State centric programming - Applications - Core challenges - Research directions - Tiered architectures - Distributed signal processing - Monitoring and Debugging - Security and Privacy. (9)

Total: 45

REFERENCES

1. *Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks An Information Processing Approach", Mogan Kaufmann Publishers, 2004.*

2. *C. S. Raghavendra, Krishna M. Sivalingam and TaiebZnati, "Wireless Sensor Networks Springer Publishers, 2006.*

15MPDE14 ROBOTICS TECHNOLOGY AND INTELLIGENCE

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To provide students with a working knowledge of methods for design and analysis of robotic and intelligent systems.
- To appraise latest modeling dynamic systems for measuring and controlling their behavior, and making decisions about future courses of action.
- To motivate and prepare students to conduct research projects and for further study through advanced courses in related areas.

COURSE OUTCOME

CO1: Ability to express the fundamentals of intelligent robotic systems with special focus on the computational aspects.

CO2: Ability to apply some of the theoretical concepts seen in class on a mobile robot (BOEbot) using an existing tool kit.

CO3: Ability to investigate the principles of mobile robots and Implement programming principles for robotic control.

INTRODUCTION

Robotics - basic components - classification - specifications, Robotic sensors - proximity and range sensors, ultrasonic sensor, touch and slip sensor. Vision system - image processing and analysis - data reduction, segmentation, feature extraction and object recognition. Robotic drives and actuators - electric, hydraulic, pneumatic - selection.

(9)

ROBOT CONTROL

Control of robot manipulator - state equations - constant solutions - linear feedback systems, single-axis PID control - PD gravity control - computed torque control, variable structure control and impedance control. (9)

ROBOT AND EFFECTORS AND TRAJECTORY PLANNING

End effectors - classification - mechanical, magnetic, vacuum and adhesive grippers. Gripper force analysis and gripper design. Work space analysis and motion analysis - pick and place operation, continuous path motion, interpolated motion, and straight line motion - manipulator kinematics - kinematic equation using homogeneous transformation and robot dynamics. (9)

ROBOT INTELLIGENCE AND TASK PLANNING

Artificial intelligence - techniques - state space - search problem reduction - predicate logic means and end analysis - problem solving - robot learning - task planning - basic problems in task planning - AI in robotics and Knowledge Based Expert System in robotics. (9)

INDUSTRIAL ROBOTICS

Robot cell design and control - cell layouts - multiple robots and machine interference - work cell design - work cell control - interlocks - error deduction and recovery - work cell controller - robot cycle time analysis. Safety in robotics, Applications of robot and future scope. (9)

Total: 45

REFERENCES

1. *Fu, K. S.Gonzalez RC., and Lee C.S.G., "Robotics Control, sensing vision and intelligence". McGraw Hill, 2008.*
2. *Robert J Schilling, "Fundamentals of Robotics: Analysis and Control", Prentice Hall of India, New Delhi, 2013.*
3. *Deb. S. R, "Robotics Technology and Flexible Machine Design", Tata McGraw Hill, 2010.*
4. *Mikell. P. Groover, Michell Weis. Roger. N.Nagel, Nicolous G Odrey, "Industrial Robotics Technology, Programming and Applications", McGraw Hill, int 2012.*
5. *Richard D Klafer Thomas A.Chmielewski and Michael Negin, "Robotic Engineering: An integrated approach", Prentice Hall of India, New delhi, 2010.*

15MPDE15 INTRODUCTION TO CHEMICAL ENGINEERING

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To provide students about the basic knowledge of chemical engineering and concept about unit operation and process.
- To perform material and energy balance calculations for process units.
- The intent to motivate the student to learn about basic Momemtum, heat and Mass transfer phenomena.

COURSE OUTCOME

CO1: Ability to express the fundamentals of chemical engineering and to solve problems.

CO2: Ability to develop basic fluid concepts, transfer and separation operations.

CO3: Ability to design equipments for transport and separation processes.

OVERVIEW OF CHEMICAL ENGINEERING

Concepts of unit operations and unit processes, and more recent developments, The Chemical Industry - scope, features & characteristics. Flow sheets, and symbols for various operations. (9)

MATERIAL AND ENERGY BALANCE CALCULATIONS

Material balances in simple systems involving physical changes and chemical reactions, systems involving recycle, purge, and bypass, combustion reactions, Forms of energy, optimum utilization of energy, Energy balance calculations in simple systems. Introduction to Computer aided calculations - steady state material and energy balances, combustion reactions. (9)

BASIC FLUID CONCEPTS

Dimensions and Units, Velocity and Stress Fields, Viscosity and surface tension, Non Newtonian viscosity, Dimensional Analysis (Buckingham PI theorem), Types of flows, Methods of Analysis, Fluid Statics, pipe flow, Pumps, Agitation and Mixing, Compressors. (9)

HEAT TRANSFER OPERATIONS

Review of conduction, resistance concept, extended surfaces, lumped capacitance, Introduction to Convection, natural and forced convection, correlations, Radiation, Heat exchangers - Fundamental principles and classification of heat exchangers, Evaporators. (9)

MASS TRANSFER OPERATIONS

Fundamental principles and classification of Distillations, Adsorption, Absorption, Drying, Extraction, Membrane Process. Energy and Mass Conservation in process systems and industries. Introduction to chemical reactors. (9)

Total: 45

REFERENCES

1. *G.T. Austin, R.N. Shreve, Chemical Process Industries, 5th ed., McGraw Hill, 1984.*
2. *W.L. McCabe, J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering, 6th ed., McGraw Hill, 2001.*
3. *R. M. Felder and R.W. Rousseau, Elementary Principles of Chemical Processes, 3rd ed., John Wiley, New York,2004.*
4. *L.B. Anderson and L.A. Wenzel, Introduction to Chemical Engineering, McGraw Hill, 1961.*
5. *H.S. Fogler, Elements of Chemical Reaction Engineering, 4th ed., Prentice-Hall, 2006.*

15MPDE16 GREEN TECHNOLOGY

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To identify the principles of green chemistry and need to recognize green criteria in the practice of technology and to develop an importance and understanding of microwave technology involved in various chemical reactions and green initiative in energy sources.
- To design the bioreactor, molecular modeling, bioprocessing and nanotechnology applications in biological systems using green criteria and to obtain a wide knowledge on manufacturing of bio plastics from green technologies.
- To govern and manage the green projects with the financial concerns.

COURSE OUTCOME

CO1: Ability to express the importance of smart energy and green infrastructure and to demonstrate safe behavior and practices in a laboratory environment.

CO2: Ability to underline the history, global, environmental and economical impacts of green technology and to identify technological systems that will function with renewable energy resources.

CO3: Ability to practice troubleshooting techniques in the installation, function, and maintenance of green technology systems. Build models that simulate sustainable and renewable green technology systems.

FUNDAMENTALS OF GREEN TECHNOLOGY

Introduction - Overview of green chemistry - Principles & development of Green Technology, Nature of chemicals and world chemical scenario, Atom economy, Less hazardous chemical syntheses, Designing safer chemicals - safer solvents - safer gasoline and auxiliaries, Inherently safer chemistry for accident prevention, Need for Green technology in day to our life. (9)

EMERGING GREEN TECHNOLOGY AND ALTERNATIVE ENERGY SOURCES

Design for Energy efficiency - Photochemical reactions - Advantages - Challenge faced by photochemical process. Microwave technology on Chemistry - Microwave heating - Microwave assisted reactions - Sono chemistry and green Chemistry. Bio refinery chemicals from fatty acids, green technology in fuel cell and electric vehicles, solar energy and hydrogen production, energy from alternate sources - Solar photovoltaic technology. (9)

GREEN BIO & NANOTECHNOLOGY

Biotechnology - Introduction and green concepts of biotechnology, Bioprocess simulation - molecular modeling for protein synthesis - drug design and protein engineering. Bioreactor design - scale up of bioreactions/reactors - Downstream processing in biochemical industry. Fermentation - Design of fermenters with modified organisms. Nanotechnology - Introduction and biological methods for synthesis of nano-emulsions using bacteria, fungi and actinomycetes, Plants based nanoparticle synthesis, Nano composite biomaterials - Fibres, devices and structures, Nano Biosystems. Nanomedical applications of green nanotechnology. (9)

GREEN PLASTICS MANUFACTURING

Introduction to commercial plastics and elastomers - Natural Rubber (NR), modified NR and blends - Polyesters from microbial and plant biofactories (polylactic acid and polyhyroxyalkanoates) - Plastics from vegetable oils - Cellulose and starch based materials - Natural fillers, fibers, reinforcements and clay nanocomposites - Biodegradability, life cycle assessment and economics of using natural materials. (9)

GREEN MANAGEMENT

Definition - green techniques and methods - green tax incentives and rebates (to green projects and companies) - green project management in action - business redesign - eco-commerce models. Environmental reporting and ISO 14001. climate change business and ISO 14064 - green financing - financial initiative by UNEP - green energy management - green product management. (9)

Total: 45

REFERENCES

1. *V.K. Ahluwalia, Methods and Reagents of Green Chemistry: An Introduction by Green Chemistry, www.clri.org.*
2. *R.S. Varma, Advances in Green Chemistry: Chemical syntheses using microwave Irradiation, Kavitha Printers, Bangalore, India, 2002.*
3. *Mao Hong fan, Chin pao Huang, Alan E Bland, Z. Honglin Wang, Rachid Silman, Ian Wright, Environmental nanotechnology, Elsevier, 2010.*
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COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE - 641 014, TAMILNADU, INDIA

DIAMOND JUBILEE
1956 - 2016

DEPARTMENT OF CHEMICAL ENGINEERING

M.Tech. PROCESS DYNAMICS AND CONTROL

UNDER CHOICE BASED CREDIT SYSTEM

CURRICULAM AND SYLLABI

(For the students admitted during the academic year 2015-2016 onwards)