Nirma University
Institute of Technology

Department of Instrumentation and Control Engineering

M Tech in Control and Automation

SYLLABUS

Semester I

3IC1101 Dynamics of Linear Systems [3 1 0 4]

Course Learning Outcome:

After successful completion of the course, student will be able to

- develop mathematical model of various LTI mechanical, electrical and electromechanical systems
- create state space model and apply various linear transformation on the model
- solve state space model
- design controller and observer of LTI systems
- examine properties of linear time variant systems

Syllabus:

State Space Descriptions: Canonical Realizations, State equations in time and frequency domain, Controllability and Observability, Solution of state model.
Linear state-variable feedback: Analysis of stabilization by output feedback, State- feed-back and model controllability, Quadratic regulator theory for continuous-time systems, Discrete-time systems.
Asymptotic observer and compensator design: Observer for state measurement, combined controller-observer compensator and reduced order observer
State feedback and Compensator design: State-space analysis of linear systems, Transfer function analysis of linear state-feedback, Multivariable quadratic regulator and Transfer function design of compensator
Time-variant systems: State model, controllability and observability, Applications

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Tutorial Work:

Tutorial work will be based on above syllabus with minimum 10 tutorials to be incorporated.

References:

1. Thomas Kailath, Linear Systems, Prentice Hall International Publication
2. Chi-Tsong Chen, Linear Systems Theory and Design, Oxford Press
3. K. Ogata, Modern Control Engineering, Prentice Hall International Publication

3IC1105 Advanced Control Theory [3 1 0 4]

Course Learning Outcome:

After successful completion of the course, student will be able to

- define and design optimal control problem for different types of linear and nonlinear systems
- know various type of uncertainties occur in control system
- define and design Robust control problem for different types of linear and nonlinear systems
- learn various control techniques like MRAC, Gain Scheduling, Adaptive control

Syllabus:

Optimal Control: Introduction, Performance indices, Optimal control of linear systems, riccati equation and its solution, two-point boundary value problem, Minimum time optimal control, Infininte and finite time horizon based optimal control, Optimal control of nonlinear systems, Introduction to Dynamic programming, Applications
Robust Control: Introduction, Need of Robust control, matched uncertainties, Mismatched uncertainties, Input uncertainties, Modeling of uncertainty, Different approaches, Robust stability, Introduction to H2/H-inf control
Adaptive Control: Preview, Need for adaptive control, Gain scheduling, Model reference adaptive control, Self tuning control, Variable structure control

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents

Tutorial Work:

Tutorial work will be based on above syllabus with minimum 10 tutorials to be incorporated

References:

1. Ken Dutton and Thomsan, The art of control engineering, Prentice Hall Publication
2. M. Abu-Khalaf, J. Huang, F. L. Lewis, Nonlinear H2/H-infinity Constrained Feedback Control: A Practical Approach Using Neural Networks, Springer Verlag Publication
3. D.S.Naidu, Optimal control systems, CRC Press
4. Feng Lin, Robust control Design, Wiley interscience Publication

3IC1108 Drives & Control [3 0 1 4]

Course Learning Outcome:

After successful completion of the course, student will be able to

- discuss the fundamental of electric drives with different types of loads
- able to design and compare various speed control strategies for dc motor
- able to carry out analysis and comparison of various scalar control strategies for ac motor speed control
- identify the need of advances in electric drives technologies to match the industrial requirements
- understand and be able to apply the advanced concepts of IM drives such as Vector Control and Direct Torque Control
- explain and compare various vector control methods used for IM drives.

Syllabus:

Fundamentals of Electric Drives: Electric drive & electric drive system, Different types of loads & load characteristics, Types & characteristics of DC motors, Characteristics of induction motor.
D.C. Motor Drives: Control of Rectifier fed DC drives, chopper Controlled DC drives, Closed loop control of DC drives, Armature voltage control at constant field, field weakening mode, Dual Converter control of DC separately excited motor, Problems.
Induction Motor Drives: Stator voltage control, Variable frequency control, Control of Induction motor by voltage source inverter: frequency controlled induction motor drives, 3-⎫ voltage source inverter, six step inverter, PWM inverter, sinusoidal Pulse Width Modulation, PWM with uniform sampling, selective harmonic elimination, Control of Induction motor by current source inverters: 3-⎫ current source inverters, Current source inverter variable frequency drives, current controlled PWM inverters, Comparison of element & voltage source inverters, Problems.
Advanced Electric Drives: Vector or Field Oriented Control, DC drive analogy, Equivalent circuit & phasor diagram, Principle of Vector control, Rotor Flux Oriented Vector Control, Direct or Feedback oriented vector control, Flux Vector estimation, Current model, Indirect or Feed forward Vector control, Stator flux Oriented Vector Control, Sensorless Vector Control, Direct Torque & Flux Control (DTC), Operating principle, Indirect vector control, Control strategy of DTC, Adaptive Control, Problems.

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:

Laboratory work will be based on above syllabus with minimum 12 experiments to be incorporated.

References:

1. G.K.Dubey, Fundamentals of Electrical Drives, Narosa Publication
2. R. Krishnan, Electric Motor Drives, PHI Publication
3. W. Leonhard, Control of Electric Drives, Springer-Verlag Publication
4. B.K.Bos, Power Electronics & A.C. Drives, PHI Publication
5. P. Vas, Vector control of A.C. Machines, CRC Press
6. G.K.Dubey, Power Semiconductor Controlled Drives, Prentice Hall Publication

3IC1109 Digital Electronics and System Design [3 0 1 4]

Course Learning Outcome:

After successful completion of the course, student will be able to

- develop an understanding of architecture of the programmable logic devices and designing of different logic blocks for the digital logic design
- perform VHDL programming of combinational and sequential , digital logic circuits
- perform VHDL programming using simulation tool and implementation on programmable logic device

Syllabus:

Sequential circuit design: Analysis of Clocked Synchronous Sequential Networks (CSSN) Modelling of CSSN, State Stable Assignment and Reduction, Design of CSSN, Design of Iterative Circuits, ASM Chart, ASM Realization, Design of Arithmetic circuits for Fast adder, Array Multiplier.

Asynchronous sequential circuit design: Analysis of Asynchronous Sequential Circuit (ASC), Flow Table Reduction, Races in ASC, State Assignment Problem and the Transition Table, Design of ASC, Static and Dynamic Hazards, Essential Hazards, Data Synchronizers, Designing Vending Machine Controller, Mixed Operating Mode Asynchronous Circuits.

Fault diagnosis and testability algorithms: Fault Table Method, Path Sensitization Method, Boolean Difference Method, Kohavi Algorithm, Tolerance Techniques, The Compact Algorithm, Practical PLA's, Fault in PLA, Test Generation, Masking Cycle, DFT Schemes, Built-in Self Test.

Synchronous design using programmable devices: Programming Techniques, Re-Programmable Devices Architecture, Function blocks, I/O blocks, Interconnects, Realize combinational, Arithmetic, Sequential Circuit with Programmable Array Logic; Architecture and application of Field Programmable Logic Sequence.

New generation programmable logic devices : Foldback Architecture with GAL, EPLD, EPLA , PEEL, PML; PROM, Realization State machine using PLD, FPGA, Xilinx FPGA, Xilinx 2000, Xilinx 3000.

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:

Laboratory work will be based on above syllabus with minimum 12 experiments to be incorporated.

References:

1. J. Bhasker, A VHDL Primer, Pearson Education Asia Publication
2. Kevin Skahill, VHDL for Programmable Logic, Prentice Hall Publication
3. Donald G. Givone, Digital principles and Design, Tata McGraw Hill Publication
4. J.F. Wakerly, Digital Design, Principles & Practices, Prentice Hall Publication

3IC1110 Simulation Laboratory [0 0 1 1]

Course Learning Outcome:

After successful completion of the course, student will be able to

- use simulation tools for analysis of system
- use simulation tools for design of system
- design controller using simulation tools

Syllabus:

Simulations will be carried out on following topics:
Control System Analysis
Design of controller: Classical and State Space Design
System Identification.
Optimal Controller design.
Robust controller design.

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:

Laboratory work will be based on above syllabus with minimum 12 experiments to be incorporated.

References:

1. F.L. Lewis, Optimal control, John Wiey & Sons Publication
2. R.V. Dukkipati, Analysis and Design of Control Systems using MATLAB, New Age International Publication
3. Ashish Tewari, Modern Control Design, John Wiey & Sons Publication

3IC1111 Industrial Automation [2 0 1 3]

Course Learning Outcome:

After successful completion of the course, student will be able to

- acquaint an understanding of fundamental principles of Programmable logic controller, I/O modules and IEC standard architecture
- develop the ability to design program using IEC standards programming software
- apprehend Interfacing of various I/O devices with PLC
- develop an understanding of the SCADA, DCS Architecture and design SCADA system using simulation software
- develop and design an application orientated project using PLC

Syllabus

Introduction to Programmable Logic Controllers : PLC system , input devices, output devices, number system , I/O processing, Fundamentals of PLC Programming, (LD, FBD, IL, ST, SFC, Arithmetic Functions, Logic Functions, Timers and Counters, Communication Instructions, Data Transfer Instructions, System Bits and Words, Advance instructions, Function Blocks, Derived Function Blocks, PID Function, Blocks) , Application example ,System Integrity and Safety.

Supervisory Control & Data Acquisition: Introduction to SCADA, Concept of Real time software, SCADA Architecture, Remote Control , Introduction to communication protocols, Creation of Database, Interfacing with PLC, Operating Screens, Application programming Simulation / RUN time, Alarms, Trends & Bar graphs, Historical Data Management.

Distributed Control System: Evolution of DCS, Design and specification, architecture, merits and demerits, Direct digital control, Evolution of hierarchical, system structure, Functional levels, Database organization, System implements concepts.

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:

Laboratory work will be based on above syllabus with minimum 12 experiments to be incorporated.

References:

1. Webb and Reis, Programmable Logic Controllers: Principles and Applications, PHI Publication
2. Stuart A. Boyer, SCADA: Supervisory control and data acquisition system, ISA Publication
3. W Boltan, Programmable Logic Controllers, Elsevier Publication
4. Ronald L Krutz, Securing SCADA system, Wiley Publication
5. Popovic & Bhatkar, Distributed computer control for industrial automation, CRC Press
6. Hackworth, Programmable Logic Controllers Programing methods and application, Prentice Hall Publication
7. Bela G. Liptak, Inst. Engg's Handbook on Process Software & Digital Networks, CRC Press

Semester II

3IC1208 **Intelligent Control** **[3 0 1 4]**

Course Learning Outcome:

After successful completion of the course, student will be able to

- learn basics of fuzzy set theory and neural networks
- implement fuzzy based decision making systems
- implement Neural Network based approximator
- design Fuzzy and Neural Network based control system
- design ANFIS based control system
- implement soft computing techniques controllers using simulation tools

Syllabus:

Motivation for Intelligent Control: Role of neural networks in engineering, Artificial neural nets (ANNs), Fuzzy logic, knowledge representation and inference mechanism, genetic algorithm and fuzzy neural networks.
Neural network: Fundamentals, Types of neural networks, Mathematical background
Neural network based learning and control: Learning methodologies, learning algorithms, neuro-fuzzy control, identification and approximation using NN, Adaptive neural network control
Fuzzy control: Fuzzy sets, Fuzzy rules and reasoning, Fuzzification and Defuzzification.
Introduction to Reinforcement learning based control.
Applications of Intelligent control.

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:

Laboratory work will be based on above syllabus with minimum 12 experiments to be incorporated.

References:

1. S. Huang, K.K. Tan and K.Z. Tang, Neural network control: Theory and applications, Research Studies press & Publication
2. Kevin Passino, Fuzzy control, Addison Wesley Publication
3. R.Sutton and A. Barto, Reinforcement Learning; An Introduction, MIT Press
4. Jang, T. Sun and E. Mizutani, Neuro-Fuzzy and Soft computing, A computational Approach to learning and machine intelligence, Prentice Hall Publication

3IC1209 Advance Process Control [3 0 1 4]

Course Learning Outcome:

After successful completion of the course, student will be able to

- ascertain need, benefits and applicability of various complex control systems
- select the best pair of controlled-manipulating variable in case of (MIMO) process
- design decoupler for MIMO process control
- carry analysis and design of IMC based controller and Model Predictive Control (DMC approach)
- understand working of various types of adaptive control system and statistical process control

Syllabus:

Review of Complex Control Systems: Cascade, Ratio, Feed forward, Selective controls, Split range control, Anti reset windup, Smith predictor, Control for inverse response system, Inferential control

Multivariable Control Systems: MIMO examples, Interaction in multivariable system, Design of decouplers, Relative Gain Array (RGA), Dynamic Matrix Control

Internal Model Control: Internal model principle, IMC based control strategy, Implementations.

Statistical Process Control: Concept of SPC, SPC based control strategies

Adaptive Control Systems: Need for adaptive control, Types of adaptive control, Design of adaptive control

Model Predictive Control: Overview, Prediction for SISO and MIMO systems, Selection of design and tuning parameters. Implementation of MPC.

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:

Laboratory work will be based on above syllabus with minimum 12 experiments to be incorporated.

References:

1. G. Stephanopolous, Chemical Process Control, PHI Publication
2. Seborg, Edgar and Mellichamp, Process Dynamics and Control. Wiley India Publication

3IC1210 Embedded System Design [3 0 1 4]

Course Learning Outcome:
After successful completion of the course, student will be able to

- understand the fundamental of ARM architecture that includes register array, cache, virtual memory, pipeline and memory management units
- understand the assembly language instructions for ARM processor
- evaluate the concept of C Programming optimization for ARM Processor
- program the ARMxx processor using assembly language and C language
- creation of small embedded system using ARM controller and realization of hardware based design through team project
- implementation of control system algorithms using ARM Controller

Syllabus:

Introduction: The RISC Design Philosophy ,The ARM Design Philosophy , Embedded System Hardware, Embedded System Software

ARM Processor Fundamentals : Registers, Current Program Status Register ,Pipeline ,Exceptions, Interrupts, and the Vector Table , Core Extensions , Architecture Revisions , ARM Processor Families

Introduction to the ARM Instruction Set : Data Processing Instructions , Branch Instructions , Load-Store Instructions, Software Interrupt Instruction , Program Status Register Instructions , Loading Constants , ARMv5E Extensions , Conditional Execution.

Introduction to the Thumb Instruction Set: Thumb Register Usage, ARM-Thumb Interworking , Other Branch Instructions , Data Processing Instructions ,Single-Register Load-Store Instructions , Multiple-Register Load-Store Instructions.

C Programming and Assembly programming overview and optimization: Writing C Programs, Function creation, Writing Assembly Code, Profiling and Cycle Counting ,Instruction Scheduling, Register Allocation, Conditional Execution, Looping Constructs, Bit Manipulation, Efficient Switches, Optimized primitives

Digital Signal Processing: Representing a Digital Signal , Introduction to DSP on the ARM Firmware , Operating Systems and Cache, Firmware and Bootloader , Example: Simple Little Operating System , Cache Architecture , Cache Policy , Flushing and Cleaning Cache Memory , Cache Lockdown , Caches and Software Performance,Memory Management Units, Moving from an MPU to an MMU , How Virtual Memory Works , Details of the ARM MMU , Page Tables ,The Translation Lookaside Buffer

Advancement in ARM processor and design using ARM Processor : Advanced DSP and SIMD Support in ARMv6 , System and Multiprocessor Support Additions to ARMv6 ARMv6 Implementations , Future Technologies beyond ARMv6 , ARM 9, ARM based SOC Design

Applications of ARM based designs in Camera, Mobile Phones etc.,

Self Study:
The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:
Laboratory work will be based on above syllabus with minimum 12 experiments to be incorporated.

References:

1. Steve Furber, ARM system-on-chip architecture, Pearson Education Publication
2. Andrew N. Sloss, Dominic Symes and Chris Wright, ARM system developer's guide: designing and optimizing system software, .Elsevier Publication
3. A P Godse, Advanced Microprocessors, Technical Publications
4. Datasheets of ARM9 Processor

3IC1211 Virtual Instrumentation Laboratory [0 0 1 1]

Course Learning Outcome:

After successful completion of the course, student will be able to

- develop ability for programming in LabVIEW using various data structures, program structures, plotting the graphs and charts for system monitoring, processing and controlling
- understand the basics of interfacing and programming using related hardware
- monitor or process system through individual /team project

Syllabus:

LabView based simulations will be carried out on following topics:

Introduction to Virtual Instrumentation, data flow techniques, graphical programming.

Programming Techniques, VIS & Sub VIS, loops & charts, arrays, clusters, graphs, case & sequence structures, formula modes, local and global variable, string & file input.

Data Acquisition basics, ADC, DAC, DIO, Counters & timers, PC Hardware structure, timing, interrupts, DMA, Software and Hardware Installation.

Common Instrument Interfaces for Current loop, RS 232C/RS 485, GPIB, System basics, interface basics: USB, PCMCIA, VXI, SCXI, PXI etc, networking basics for office & industrial application VISA & IVI, image acquisition & processing, Motion Control.

Use of Analysis Tools, Fourier transforms, Power spectrum, Correlation methods, Filtering.

Application of VI in Process Control, Development of instruments like oscilloscope, Digital Millimeter using LabView ,Study of Data Acquisition & control using Lab view.

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:

Laboratory work will be based on above syllabus with minimum 12 experiments to be incorporated.

References:

1. Sanjay Gupta and Joseph John, Virtual Instrumentation Using LabVIEW, Tata McGraw-Hill Publication
2. Jeffery Travis and Jim Kring , LabVIEW for Everyone: Graphical Programming Made Easy and Fun, Pearson Education India Publication
3. Jovitha Jerome, Virtual Instrumentation Using LabVIEW, PHI Publication
4. Rick Bitter, Taqi Mohiuddin and Matt Nawrocki, LabVIEW: Advanced Programming Techniques, CRC Press
5. Jeffrey Y. Beyon, Hands-on Exercise Manual for LabVIEW Programming, Data Acquisition and Analysis, Prentice Hall PTR Publication

3IC1212 **Seminar** **[0 0 1 1]**

Course Learning Outcome:

After successful completion of the course, student will be able to

- carry out intense study on a specific topic related to current development in their field of specialization
- collect, interpret and analyze the information
- compare and evaluate the existing solutions for a specific cases study
- develop skills of presentation and report writing
- develop a skill to work in a team

Syllabus:

A student is required to select an advanced topic relevant to field of study. Student should submit report based on his/her study and is required to make presentation for evaluation.

3SP1204 Research Methodology (Supplementary Course) [0 1 0 0]

Course Learning Outcome:
After successful completion of the course, student will be able to

- appreciate the importance of literature survey and problem identification for formulating an effective research topic
- integrate the functionality of Mathematical modeling and Statistical analysis for understanding intricacies of the research work
- prepare research plan inclusive of experimental design
- effectively communicate with peer groups and technical diaspora using technical research papers and thesis or reports

Syllabus:
Introduction: Objective of research, motivation in research, types of research, interdisciplinary research, scientific methods of research, criteria of good research, characteristics of a good researcher.
Defining Research Problem: Art of literature review, user of ICT in effective literature review, formulation of problem, formulation of hypothesis, developing research plan, meaning of research design, types of research design, basic principles of experimental design, selection of relevant variables, validity of experiments.
Data Collection and Utilization: Types of data, methods & techniques of data collection, sampling, characteristic of a good sample design, methods used in sampling, sampling errors, tests of hypothesis.
Quantitative Methods: Data presentation, statistical analysis and interpretation of data, types of analysis, simple regression analysis, correlation, coefficient of determination (r^2), z-test, t-test, ANOVA, Chi-square test, multi-variate analysis of data, multiple regression.
Computer Application: Role of computer in research, data organization, software selection and its applications, solving problems by using scientific software & tools, sample programmes for analysis of data.
Thesis Writing and Presentation: Significance of writing thesis, different types of research writing; conference paper, journal paper, patents, thesis etc., different steps in writing thesis, layout of thesis, guidelines for writing good thesis, precautions in writing thesis, presentations skills, defending the thesis.

Tutorial Work:
Tutorial work will be based on above syllabus with minimum 05 tutorials to be incorporated.

References:

1 C R Kothari, Research Methodology: Methods & Techniques, Vishwa Publication
2 D K Bhattacharyya, Research Methodology: Excel Books
3 Loraine Blaxter, Christina Hughes and Molcolm Tight, How to Research, Viva Books Publication
4 Paul Oliver, Writing Your Thesis, Vistaar Pulication
5 Pat Cryer, The Research Student's Guide to Success, Viva Books Publication

Semester III

3IC1301 **Project- I** **[0 0 0 15]**

Course Learning Outcome:

After successful completion of the course, student will be able to

- understand the issues related with the recent trends in the field of engineering and its applications.
- formulate the problem definition, analyze and do functional simulation of the same
- design, implement, test and verify the engineering solution related to problem definition
- compile, comprehend and present the work carried out
- manage project

Syllabus:

Project-I is aimed at training the students to analyze independently any problem in the field of Control and Automation. The project may be analytical or computational or experimental or combination of them based on the latest developments in area mentioned.

At the end of the semester, the students will be required to submit detailed report. It should consist of objective of study, scope of work, critical literature review and preliminary work done pertaining to the project undertaken and will defend his/her work carried out before the examiners at the time of final evaluation.

3SP1301 Practical Training (Supplementary Course) [0 0 0 0]

Course Learning Outcome:
After successful completion of the course, student will be able to

- explore the preferred field of specialization and develop analytical / hardware / software / experimental skills
- manage the technical content and work
- prepare and present technical report

Syllabus:

During practical training of 4-6 weeks, students will learn required software tools/ methodologies, either in industry/research organizations/academic institutions etc. or there will be a planned in-house training by our faculty members/experts from other organizations that will help them in their PG dissertation work.

Semester IV

3IC1401 **Project– II** **[0 0 0 15]**

Course Learning Outcome:

After successful completion of the course, student will be able to

- understand the issues related with the recent trends in the field of engineering and its applications.
- formulate the problem definition, analyze and do functional simulation of the same
- design, implement, test and verify the engineering solution related to problem definition
- compile, comprehend and present the work carried out
- manage Project

Syllabus:

Project-II is a continuation of the work done by the student during Semester III. The student is required to submit the project report (thesis) as a partial fulfillment of the M. Tech. degree. The project report should include the work of Project-I, which is completed before. In addition, the project report should consist of the detailed study of the project undertaken, concluding remarks, and future scope of work, if any. The project report is expected to show clarity of thought and expression, critical appreciation of the existing literature and analytical computation and experimental aptitude of the student, as applicable.

At the end of the semester, the students will be required to submit a detailed report and will defend his/her work carried out before the examiners at the time of final evaluation.

ELECTIVE I

3IC1214 Sensors and Signal Conditioning [3 0 0 3]

Course Learning Outcome:

After successful completion of the course, student will be able to

- understand voltage and current mode architectures used in analog signal processing
- design signal conditioning circuits for filtering and waveform shaping
- understand MEMS & NEMS technology
- understand & apply the techniques for noise, drift & interference reduction

Syllabus:

Sensors: Fundamentals of sensors, Packaging and characterization of sensors, MEMS and NEMS
Signal conditioning: Signals and signal processing, Voltage amplification, Current-to-Voltage and Voltage-to-Current Conversion, Linear analog Functions, AC/DC Signal Conversion. Other nonlinear analog Functions, Analog signal filtering, Analog Signal switching, Multiplexing and Sampling, Error Analysis and Reduction, Interference and Its Reduction., Noise, Drift and their Reduction.

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

References:

1 John G Webster, Analog Signal Processing, Wiley Eastern Publication
2 H. Meixner, Sensors: Micro & Nano sensors, Sensor Market trends, Wiley Publication
3 P. Rai Choudhury, MEMS & MOEMS Technology and Applications, SPIE Press Publication

3IC1224 Image Processing [3 0 0 3]

Course Learning Outcome:
After successful completion of the course, student will be able to
- understand the fundamentals of image processing and associated techniques
- apply the basic algorithms in Image processing applications

Syllabus:
Introduction of image processing: Image acquisition and representation. Visual perceptual processing. Image quality and information content. Two-dimensional systems and transforms. 2D convolution. 2D Fourier transform. Point spread function and system transfer function. Matrix and vector representation of images, linear system operations and transforms.
Removal of artifacts: Random noise. Structured artifacts. Methods to remove artifacts.
Image enhancement: Contrast enhancement. Histogram operations. Spatial and frequency-domain filtering, Algebraic operations with images. Local, global, and adaptive methods. Detection of regions of interest: Edge detection. Segmentation and region growing. Detection of objects of known geometry.
Analysis of shape and texture: Moments. Fourier descriptors. Shape factors, Statistical and structural analysis of texture. Image reconstruction from projections: Projection geometry. Backprojection, Fourier, convolution backprojection and algebraic reconstruction techniques. Fundamentals of computed tomography.
Image restoration: Degradation models. Inverse filter. Wiener filter. Deblurring. Image coding: Information theory. Source-coding techniques and data compression . Decorrelation techniques. Huffman, run-length, predictive, interpolative, and transform coding.
Applications: Vision based control, Image analysis and computer vision: Feature representation and pattern classification, Case studies from image processing research journals.

Self Study:
The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

References:

1. R. M. Rangayyan, Biomedical Image Analysis, CRC Press
2. R.C. Gonzalez and R.E. Woods, Digital Image Processing, PHI Publication
3. Jerry L. Prince and Jonathan Links, Medical Imaging: Signals and Systems, Prentice Hall Publication
4. A. Rosenfeld and A.C. Kak, Digital Picture Processing, Academic Press

3IC1234 Parameter Estimation and Optimization Techniques [3 0 0 3]

Course Learning Outcome:

After successful completion of the course, student will be able to

- develop estimators for different types of linear and nonlinear systems.
- estimate the parameters of the linear and non linear system using different parameter estimation
- techniques.
- estimate and filter the states of the linear system using Kalman Filter.

Syllabus:

Estimation: Introduction, development of parameter estimators, estimation of stochastic processes, applications. Least–square estimation. Linear least squares problem, generalized least square problem. Sequential least squares, non-linear least squares theory, Estimation and the Maximum Likely hood method- Instrument Variable method, Recursive and Weighted Least square method, State estimation using Kalman Filtering.

Optimization Techniques:

Derivative based Optimization: Gradient methods, Newton's method, Nonlinear least-squares method

Derivative free optimization: Genetic Algorithm, Ant colony optimization, Simulated Annealing.

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

References:

1. Oliver Nelles, Nonlinear system Identification, Springer Publication
2. Goldberg ,Genetic Algorithm, Addison-Wesley Publication
3. Jang, T. Sun and E. Mizutani, Neuro-Fuzzy and Soft computing: a computational approach, Prentice-Hall Publication
4. Ashish Tewari, Morden Control Design. John Wiley & Sons Publication

ELECTIVE II

3IC1225 Power Plant Automation and Optimization [3 0 0 3]

Course Learning Outcome:

After successful completion of the course, student will be able to

- assess various operational aspects of power plant and compare thermal, nuclear and hydro power plants
- demonstrate proficiency in analysis of various control systems of thermal power plant
- understand various subsystems of thermal power plant like – coal and ash handling system, fan systems, feed water treatment, etc.,
- understand significance of various health monitoring parameters and their supervisory system for steam turbine
- understand optimization strategies for thermal power plants

Syllabus:

Introduction: Plant overview, Classification of power plants: thermal, hydro, combined cycle and nuclear, Role of Control and instrumentation in power plant

Thermal Power Plant Process and Control: Boiler operation, Drum level control, Combustion control, Measurement and analysis of gas, Steam Temperature, Level, Pressure and Flow control.

Power Plant Subsystem Automation: Forced draught control, Feed water treatment, Fuel Handling Plant Ash handling and dust collection system, Electrostatic Precipitators

Turbine and its control: Types and working of Turbine, Turbovisory system, Boiler-following-turbine load control, Turbine Interlock and Protections

Power Plant Optimization: Overview of optimization, Need of optimization in Power Plant, Excess air optimization, Multivariable Envelope Control, Steam pressure optimization, Water side optimization, Performance measurement of power plant, Fuel savings through optimization

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

References:

1. Arora and Domkundwar, Power Plant Engineering, Dhanpatrai and Sons Publication
2. Bela G. Liptak , Instrumentation Engg's Handbook on Process Control, CRC Press
3. Krishnaswamy K, Bala M, Power Plant Instrumentation, PHI Publication

3IC1245 Data Communication and Control System Architecture [3 0 0 3]

Course Learning Outcome:

After successful completion of the course, student will be able to

- understand the concepts of OSI model, Communication methods, networks in Process Automation and structure of different protocols
- acquaint with the knowledge of various open and proprietary communication protocols
- understand the real time Applications of the Communication protocols in fields of Process Automation and its role in remote location control
- apprehend the essential ideologies of Distribute Control System and Supervisory Control and Data Acquisition System
- develop the ability to design communication frame for different type of industrial applications

Syllabus:

Introduction to Networks in Process Automation : Data Communication basics, OSI reference model, Industry Networks – Device Networks, Control Networks, Enterprise Networking , Network selection.
Proprietary and open networks: Network Architectures, Building blocks, Industry open protocols (RS-232C, RS- 422, RS-485), Ethernet, Modbus, Modbus Plus, Data Highway Plus, Advantages and Limitations of Open networks.
Fieldbus: Fieldbus Trends, Hardware selection, Fieldbus design, Installation, Documentation, Fieldbus advantages and limitations, Study of Foundation Fieldbus & Profibus
HART: Introduction, Design, Installation, calibration, commissioning, Application in Hazardous and Non-Hazardous area.
Introduction to wireless Protocols: WPAN, Wi-Fi, Bluetooth, ZigBee, Z-wave.
Networked Control: Introduction, Issues of control in networked system
Distributed Control Systems: Architecture of DCS, Specifications and selection criteria for DCS. Configuration of DCS blocks, Interfacing with PLC , Plant wide database management, Security and user access management, MES, ERP Interface.

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

References:

1 B.G. Liptak, Process Software and Digital Networks, CRC Press
2 John Park,Steve Mackay, Edwin Wright, Practical Data Communications for Instrumentation and Control, Elsevier Publication
3 Nitaigour P.Mahalik, Fieldbus Technology: Industrial Network Standards for Real-Time Distributed Control, Springer Publication