COURSES OF STUDY (Syllabus)
M. Tech. (INSTRUMENTATION)
(Effective from Academic Year 2012-13)

Department of Instrumentation Engineering,
SGGS Institute of Engineering and Technology, Vishnupuri, Nanded-431606 (MS), India

(An autonomous institute established by Govt. of Maharashtra)

COURSES OF STUDY (Syllabus)
M. Tech. (Instrumentation)
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Course Code	Name of the Course	Total No of credits	Lectures/ week	Practicals/ week
	Part I			
MIN501	Process Instrumentation	4	3	2
MIN502	Advanced Digital Signal Processing	4	3	2
MIN503	Modern Control Theory	4	3	2
MIN504	Biomedical Instrumentation	4	3	2
MIN505	Seminar I	1	-	2
	Elective I	4	3	2
MIN511	Probability, Statistics and Stochastic Processes			
MIN512	Advanced Power Electronics			
MIN513	Neural Networks in Control Systems			
	Sub Total	**21**	**15**	**12**
	Part II			
MIN531	Instrumentation System Design	4	3	2
MIN532	Computer Process Control	4	3	2
MIN533	Intelligent Instrumentation	4	3	2
MIN534	Seminar II	1	-	2
	Elective II and Elective III	4+4	3+3	2+2
MIN541	Optimal and Robust Control			
MIN542	Fuzzy based Control Systems			
MIN543	Applied Nonlinear Control			
MIN544	Adaptive Control Systems			
MIN545	Estimation and Identification			
MIN546	Digital Image Processing			
MIN547	Computational Methods of Optimization			
	Sub Total	**21**	**15**	**12**
	Total	**42**	**30**	**24**
	Part III			
MIN 561	Dissertation Part-I	**22**	**-**	**22**
	Part IV			
MIN 562	Dissertation Part-II	**22**	**-**	**22**
	Grant Total	**86**	**30**	**68**

EXAMINATIONS

Examination system: Students are informed to see the examination scheme given in the rules and regulation book published by the institute of the academic year 2012-13.

Part-I

MIN501 Process Instrumentation (4 Credits, L3-T0-P2)

Course Objective

This course is designed to M. Tech. - first year, first semester course considering that admitted students are from different branches like Instrumentation, electrical, electronics and electronics- telecommunications. This course is provided by the Department of Instrumentation Engineering. It is designed to achieve the following objectives:

1. Introduce basic fundamentals of Instrumentation Engineering.
2. To elaborate different concepts of Instrumentation engineering like different transducers, their dynamic and static characteristics, errors in measurement.
3. Analysis and investigations of the basic control schemes starting from discontinuous controller to continuous controller and other process control design basics.
4. To make students familiar about different pneumatic controllers, hydraulic controllers and electronic controllers.
5. To introduce the students regarding different unit operations and their instrumentation and control.

Course Outcomes

Upon successful completion of this course, a student should be able to:

1. Know the application of different transducers, calculation of errors in measurement,
2. Experimental determination of transfer functions of the sensors or systems.
3. Be conversant with application of different controllers and their applications to suitable process.
4. Know the constructional details, principle of operation, and performance of different unit operations and their Instrumentation.

Syllabus

1. Introduction to performance characteristics of different transducers and systems, Dynamic analysis of measurement systems, errors in instrumentation systems
2. Introduction to process control, representative process control problems, classification of process control strategies, Major steps in control system developments
3. Introduction to Unit Operations and theoretical modeling, concept of Unit and Unit Operation, Material Balance and Energy Balance, Introduction to Evaporation, Distillation, Crystallization processes and associated Instrumentation and control, Introduction to process equipments like Continuous Stirred Tank Reactor (CSTR), Heat Exchanger, liquid storage systems and their modeling, dynamic behavior of first and second order processes, dynamic response of the processes, development of empirical models for process data
4. Overview of process control system design: introduction, degree of freedom for process control, selection of controlled, manipulated and measured variable, process safety and process control
5. Control system instrumentation, introduction, basic control modes, on-off controller, features of PID controller, PID controller design, tuning and trouble shootings, digital version of PID controller, electronic/pneumatic/hydraulic controller, optimum control settings, transducers, transmitters, transmission lines, final control elements and their calculations and selection
6. Feed forward and ratio control, cascade control: introduction to Feed forward and ratio control, cascade control and their design consideration, tuning.

Practical: Based on above syllabus minimum eight experiments/tutorials/assignments.

Reference Books

1. Process dynamics and control by Dale E. Seborg, Thoman F. Edgar, Dyncan A. Mellichamp, IInd Edition , Willey publication
2. Instrument Engineers Handbook by B. G. Liptak Vol. I and II, Third Edition, Chilton and Book Company, 1990.
3. Process control by Peter Harriot Tata McGraw hill
4. Automatic process control by D. Ekman,Wiley Eastern Ltd
5. Process control system Application,Design and tunning by F.G. Shinsky McGraw hill
6. Unit operation and chemical engineering by Mc Cabe McGraw hill Publication
7. Chemical process industries by Shreve McGraw hill Publication

MIN502 Digital Signal Processing (4 Credits, L3-T0-P2)

Course Objectives

1. To provide complete view of Digital Signal Processing subject with conceptual clarity in first few lectures
2. To study fundamentals of multirate signal processing and filter banks
3. To study the fundamentals of wavelet transform, multiresolution formulation of wavelet transform and implementation of wavelet transform using filter banks.
4. To develop the foundation for modeling of signal, linear prediction and estimation theory.

Outcomes

1. An ability to apply knowledge of mathematics, science, and engineering to the analysis and design of digital system
2. An ability to identify, formulate and solve engineering problems in the area signal processing.
3. An ability to use the techniques, skills, and modern engineering tools such as Matlab and digital processors.
4. An ability to function on multi-disciplinary teams
5. An ability to design a system, components or process to meet desired needs within realistic constraints such as economic, environmental, social political, ethical, health and safety, manufacturability and sustainability

Syllabus

1. Fundamentals of DSP background and review discrete time random signals.
2. Quantization effects: - Effect of round of noise in digital filter, zero input limit cycles in fixed point realization of IIR digital filters. Effects of finite register length in DFT computations.
3. Multirate digital signal processing: Fundamentals of Multirate systems, Basic multirate operations, Decimation, interpolation, filter design and implementation of sampling rate conversion, polyphase filter structures, time variant filter, structures, multistage implementation of sampling rate conversion of BP signals, sampling rate conversion by an arbitrary factor, interconnection of building blocks, polyphase representation, multistage implementations.
4. Wavelet Transform: Introduction to wavelets, wavelets and wavelet expansion systems, discrete wavelet transform, multiresolution formulation of wavelet systems, Haar

Wavelet and other wavelet representations, scaling function, wavelet functions, Parseval's theorem,

5. Multirate filter banks: Maximally decimated filter banks, errors created in QMF banks, simple alias free QMF system, power symmetric filter banks, M channel filter banks, polyphase representation, PR systems, alias free filter banks, Linear phase PR QMF banks, cosine modulated filter banks, Wavelet transform and its relation to multirate filter banks, paraunitary PR filter banks, Applications of multirate signals processing narroband LPF, suband coding of speech.
6. Linear Prediction: Innovations representation of a stationary random process, forward and backward linear prediction, solutions of the normal equations (Levinson-Durbin algorithm and Schur algorithm)
7. Power Spectrum Estimation: Parametric and non-parametric methods for power spectrum estimation.

Reference Books

1. Multirate filters and Filter banks: P. P. Vaidyanathan, PH International, Englewood Cliffs
2. Multirate signal Processing: Rabiner and Schafer, PH Inernational, Englewood Cliffs
3. Introduction to Wavelets and Wavelet Transform: C. S. Burrus, Ramesh and A. Gopinath, Prentice Hall Inc.
4. Digital Signal Processing: Principles, Algorithms, and Applications: J. G. Proakis and D. G. Manolakis; Prentice Hall of India Ltd, 1995.
5. Discrete-Time Signal Processing; A. V. Oppenheim and R. W. Schafer; ; Prentice Hall of India Ltd, 1997.

MIN503 Modern Control Theory (4 Credits, L3-T0-P2)

Course Objectives

The course is designed to provide students with an understanding of linear system concepts and multivariable system design. The course is also aimed at introducing mathematical background required for multivariable system analysis and design. The course emphasizes the state space approach and polynomial fraction method of transfer matrices for linear system analysis and design.

Outcomes

1. Analyze dynamics of a linear system by solving system model/equation or applying domain transformation.
2. Realize the structure of a discrete time system and model its action mathematically.
3. Examine a system for its stability, controllability and observability
4. Implement basic principles and techniques in designing linear control systems.
5. Formulate and solve deterministic optimal control problems in terms of performance indices.
6. Apply knowledge of control theory for practical implementations in engineering and network analysis

Syllabus:

1. Mathematical Preliminaries: Linear vector spaces and linear operators: Fields, vectors and vector spaces, Linear dependence, Dimension of linear space, The notion of bases, Linear transformation and matrices, Scalar product and norms, Quadratic function and definite matrices, vector and matrix norms, Gram determinant, Solution of linear algebraic equation: Range space, Rank, Null space and nullity of a matrix, Homogenous

and nonhomogeneous equations, Eigenvalues and Eigenvectors and a canonical form representation of linear operators, Functions of square matrix: Caley-Hamilton theorem.

2. State Space Description for multivariable Control Systems: The concept of state and state models, State equations for dynamic systems, State equations using phase, physical and canonical variables, Plant models of some illustrative control systems, State space representation and realization of transfer matrices, Minimal realization, Solution of state equation.
3. Multivariable Control Systems Analysis: Concept of Controllability and Reachability, Observability and Constructibility, Controllable and Uncontrollable subspace, Observable and unobservable subspace, Controllability and Observability tests: Kalman's test matrix, Gilbert's test, Popov-Belevitch-Hautus test, Controllability and observability canonical forms, Stability and stabilizability theory.
4. Multivariable Control Systems Design: Linear state variable feedback: The effect of state feedback on controllability and observability, Necessary and Sufficient condition for arbitrary pole placement, Ackermann's formula for pole placement, State observers: Full-order state observers and minimum order observers, Study of some physical plant like inverted pendulum for analysis and design.
5. State Space and Matrix-Fraction Descriptions of Multivariable systems: State observability, controllability and matrix-fraction descriptions, Some properties of polynomial matrices, Some basic state space realization, The Smith-McMillan form of a transfer function matrix, Poles and Zeros of a transfer function matrix, Matrix-fraction description (MFD) of a transfer function, State space realization from a transfer function matrix, Internal stability, The generalized Nyquist and inverse Nyquist stability criterion.

Reference Books

1. C. T. Chen, Linear System Theory and Design, Holt, Rinehart and Winston, New York, 1984.
2. T. Kailath, Linear Systems, Prentice-Hall, Englewood Cliff's, NJ, 1980.
3. M. Gopal, Modern Control System Theory, Second Edition, New Age International (P) Limited, New Delhi, 1996.
4. W. A. Wolovich, Linear Multivariable Systems, Springer-Verlag, and Berlin, 1974.
5. P. J. Antsaklis and A. N. Michel, Linear Systems, McGraw-Hill International Editions, 1998.
6. K. Ogata, Modern Control Engineering, Third Edition, Prentice-Hall of India, New Delhi, 1997.

MIN504 Biomedical Instrumentation (4 Credits, L3-T0-P2)

Course Objectives

1. This course is designed to provide students with an understanding of fundamental principles of body parameters measurement.
2. To familiarize the students with concepts related to the operation, analysis and applications of Biomedical Instruments.

Course Outcomes

1. To understand the basic need of biomedical instrumentation. Purpose of biomedical instrumentation. Working of different Biomedical Instruments.
2. To understand the physiology of biomedical system and different methods in the design of biomedical instruments.

3. To understand the safety requirements of handling biomedical instruments.
   To understand the operation, maintenance, selection and calibration of Biomedical Instruments.

Syllabus

1. Introduction to instrumentation, Biomedical Instrumentation, classification of Biomedical Instruments, Justification of biomedical instrumentation, Scope for Biomedical Engineers.
   Introduction to Human Body, Anatomy, Physiology, Electrophysiology, Electrode system, Electronics
2. Basic Principal, Construction Classification, operation, testing, design, problems analysis, research, manufacturers, safety, application, artifacts costing, electronics, software, hardware etc of:
   i. BP Apparatus ii. Audiometers iii. EEG iv. X-ray v. Dialyser vi. Pacemaker vii. Difibrillator viii. Phonocardiograph ix. Spirometer x. Blood Analysis Instruments.
3. Electrical properties of tissues, Shock Analysis, Shock Prevention, Instrument Safety Design, cases, electric systems design, safety standards
4. Design of biomedical instrumentation for utility, safety ergonomics, cost, space, ventilation, operation, maintenance, installation requirement. Documents, testing, design problem and solutions.
5. Biomedical signal processing: ECG signal analysis, ECG QRS detection EEG signal analysis for Epilipsy, $\propto\beta\theta\delta$ activity, artifact detection and elimination, intelligent testing.

Reference Books

1. S. G. Kahalekar, Introduction to Biomedical Instrumentation, Sadhudha Prakashan, Nanded. 1998.
2. J. G. Webster, Biomedical Instrumentation, John Wiley and Sons, Hoboken, NJ, 2004.
3. J. Carr and J. Brown, Introduction to Biomedical Equipment Technology, Pearson Education, 2000.
4. R. S. Khandpur, Hand book of Biomedical Instrumentation, Prentice Hall of India Pvt Ltd, New Delhi, India, 1996.
5. W.J. Tomplans, Biomedical digital signal processing PH publication, New Dehli 2004

Elective I

(A student will have to select any one elective subject from following for part I)

MIN511 Probability, Statistics and Stochastic Processes (4 Credits, L3-T0-P2)

Course Objectives

The major objectives of this course include:

1. Understanding and have a working knowledge of the basic axioms and identities of probability theory
2. Developing the ability to determine probability distributions and densities for transformed random variables
3. Ability to understand and apply basic statistical methods
4. Be able to apply the methods of stochastic processes to everyday problems

Outcomes

The course gives the background for simple analytical derivation and numerical calculations for stochastic processes in discrete and continuous time.

Syllabus

1. Probability and random variables: Meaning of probability, axioms of probability, repeated trials, concept of random variable, Distributions and density functions, Conditional probability and total probability
2. Functions of one random variable: random variable g(x), distribution of g(x), mean, variance, moments, characteristic functions, two random variables, bivariate distribution, one function of two RVs, two functions of two RVs
3. Moments and conditional statistics, joint moments, joint characteristic functions, conditional distributions, conditional expected values
4. Sequences of RVs: Conditional penalties, characteristic functions and normality, Mean square estimation, stochastic convergence and limit theorems, random numbers: meaning and generation,
5. Introduction to stochastic processes: Definition and classification, Markov chains, Stationary distribution and ergodicity, Wiener process, Gaussian process, Elements of time series.

Reference Books

1. A. Papoulis, Probability, Random variables and stochastic processes, McGraw Hill, 1991.
2. Starks and Woods, Probability and Estimation Theory, Prentice-Hall
3. M. R. Spiegel, Probability and Statistics, Schaum's Outline Series, McGraw -Hill Book Company, 1982.

MIN512 Advanced Power Electronics (4 Credits, L3-T0-P2)

Course Objectives

• To understand the concept of resonant switch converters.
• To analyze the factors affecting harmonics and electromagnetic Interference.
• To understand the concepts of power devices and their usage in power systems.
• To learn the advanced Power Electronic Devices and their applications.

Course Outcomes

A student who successfully fulfills the course requirements will have demonstrated:

1. An ability to understand basic operation of various power semiconductor devices and passive components.
2. An ability to understand the basic principle of switching circuits.
3. An ability to analyze and design an AC/DC rectifier circuit.
4. An ability to analyze and design DC/DC converter circuits.
5. An ability to analyze DC/AC inverter circuit.
6. An ability to understand the role power electronics play in the improvement of energy usage efficiency and the development of renewable energy technologies.

Syllabus

1. Introduction: Modern power semiconductor devices and their characteristics, gate drive specifications, ratings, applications, Design of gate triggering circuits using UJT, PUT, Diac, and Thyristor protection circuits.
2. Thyristor Commutation Techniques: Principle of Natural commutation, Design of Forced commutation circuits: Self-commutation, Impulse commutation, resonant pulse commutation, Complementary commutation, and External pulse commutation.
3. Phase Controlled Rectifiers: Single-phase rectifiers: Half wave, Centre tapped, Bridge (half controlled and fully controlled) with R and RL load.
   Three phase rectifiers: Half wave, Bridge (half controlled and fully controlled) with R and RL load. Results should be extended to m-phase rectifiers with single quadrant and two quadrant operations, Effect of source inductance, voltage and current harmonics analysis, and dual converters.
4. DC Chopper: Basic chopper, continuous and discontinuous current conduction, TRC, CLC methods, classification of choppers, source filter, multiphase choppers, step-up chopper.
5. Inverters: Single-phase inverters: series, parallel and bridge configurations with R and RL load, PWM inverters. Three phase inverters with 120° and 180° conduction with R and RL load, voltage control and harmonics reduction.
6. Cycloconverters: The basic principle of operations of single phase to single phase, three phase to single phase, three-phase to three-phase with circulating and non-circulating mode.
7. Speed control of DC motors: Using different rectifiers, principles of regenerative braking, principles of two/ four quadrant chopper drives, control using multiphase choppers, microprocessor control of DC drives.
8. Speed control of AC motors: Stator voltage control, rotor voltage control, frequency control, voltage and frequency control, microprocessor control of AC drives.

Reference Books:

1. M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, *Prentice Hall of India Private Limited, New Delhi-110 001(India),* 2nd Edition, 1994.
2. M. D. Singh, K. B. Khanchandani, Power Electronics, *Tata McGraw-Hill Publishing Company Limited, New Delhi (India)*, 1998.
3. P. S. Bimbhra, Power Electronics, *Khanna Publishers, Delhi-110 006 (India),* 2nd Edition, 1998.
4. M. Ramamooty, An Introduction to Thyristors and Their Applications, *Affiliated East-West Press Private Limited, New Delhi-110 020 (India)*, 2nd Edition, 1991.
5. N. K. De, P. K. Sen, Electric Drives, Prentice *Hall of India Private Limited, New Delhi-110 001(India),* 1999.
6. G. De, Principles of Thyristorised Converters*, Oxford and IBH Publications*, 1982.

MIN513 Neural Networks in Control Systems (4 Credits, L3-T0-P2)

Course objectives

This course presents an overview of the theory and applications of artificial neural network to engineering applications with emphasis on it use for process control applications. The objective of this course is on the understanding of various neural network and the applications of these models to solve engineering problems.

Course Outcomes

After completing the course, students will:

1. Understand the basic neural networks paradigms
2. Understand the basic concepts of training in neural networks
3. Be familiar with the range of ANN applications
4. Have a good understanding of the techniques for identification and control of the nonlinear processes
5. Have a good understanding of the techniques for designing successful applications
6. Gain hands-on experience with ANN applications for online process control applications

Syllabus

UNIT-I

Introduction and Fundamentals of Artificial Neural Networks. Biological prototype. Artificial Neuron Single Layer ANN, Multi layer ANN, training of Artificial NN.

UNIT-II

Perceptrons: Perceptron representation, perceptron learning, perceptron training algorithm. Back Propagation: Introduction to Back propagation and back propagation training algorithm, counter propagation networks.

UNIT-III

Kohonen self organizing networks: Introduction to the kohonen algorithm, weight training, Gross berg layer, Training the Gross berg layer.

UNIT-IV

Hopfield Networks: Introduction, The Hopfield model, Hopfield network algorithm, Bolt Mann's Machine, applications of Hopfield network, associative memories, bidirectional associative memories.

UNIT-IV

Adaptive Resonance Theory (ART): Architecture of Adaptive resonance theory, Algorithm for training of ART, Applications

UNIT-V

Process modelling and control: Introduction; Overview of process control applications; Why neural networks in process control? Process Modelling by neural network; Direct Adaptive Control; Self Tuning Controller; Indirect Adaptive Control; Model Reference Adaptive Control; Internal Model Control; Model Predictive Control; Cascade Control.

Reference books

1. J.M. Zurada, Introduction to Artificial Systems, Singapore: Info Access and distribution, 1992.
2. James A. Anderson, An introduction to neural networks, Prentice Hall of India, Private limited, New Delhi, 1999.
3. S. Haykin, Neural Networks: A Comprehensive Foundation, Macmillan College Publishing Company, 1994.
4. Saxena S.C., Vinod Kumar, Waghmare L.M., Neural network approach for the cascade control of interconnected system, published in the journal of Reseach of Institution of Electronics and Telecommunication Engineering (IETE) in Vol.48 No.6, pp. 461-469, Nov. Dec. 2002.

Part II

MIN531 Instrumentation System Design (4 Credits, L3-T0-P2)

Course Objectives

1. Understand the health and safety implications of working with process control systems
2. Appreciate the operation of typical instrumentation systems
3. Identify the various methods of signal transmission
4. Correctly connect electrical or air-powered devices
5. Understand the equipment used in
    a. current loops (process meters, trip amplifiers, transmitters, current repeaters, chart recorders)
    b. temperature measurement (RTDs, thermocouples, etc)
    c. pressure measurement (bourdon gauges, air and electrical dp cells)
    d. level measurement (bubblers, pressure cells, ultrasonic, load cells)
    e. flow measurement (orifice plates, mag-flow meters, mass-flow meters, weirs, flumes, etc)
    f. output devices (flow control valves, valve positioners, I to P converters)
6. Correctly use a range of industrial calibration equipment (current sources, thermocouple and RTD simulators, digital pressure indicator/calibrators.
7. Correctly connect commission and calibrate current loop devices, temperature transmitters, pressure switches, pressure sensors, dp cells, ultrasonic level meters, load cell amplifiers, I to P converters.

Outcomes

1. Be able to interpret and formulate design specifications for instrumentation systems that meet accuracy and sampling speed requirements.
2. Understand the principles of operation of sensors including thermocouples, strain gages (including Wheatstone bridge circuits) and chemical electrodes.
3. Understand principles of analog and digital signal and data processing, including amplifiers, filters and A-D conversion techniques. Understand sources and measures of error in instrumentation systems, including noise; aliasing; common-mode rejection ratio of differential amplifiers; the sampling theorem and its application.
4. Be able to design, construct, and verify an instrumentation system to meet desired specifications, with the aid of computer-aided design techniques.
5. Be familiar with safety issues concerning design of instrumentation, including the effects of electric current through tissue and defibrillation.

Syllabus

1. Introduction to Instrumentation System Design (ISD), Scope of ISD in Process Industry.
2. General transducer Design, Selection of Transducer, General procedure for Testing of transducer.
3. Design of RTD, T/C, Thermister based Temperature Instrumentation
4. Design of Pressure Gauge, Bellows, Bourdon Tube, and Diaphragm based Pressure Instrumentation.
5. Design of Orifice, Rotameter, Venture, based flow Instrumentation
6. Design of LVDT, Strain Gauges, and Piezoelectric Crystal based Displacement Instrumentation.

7. Design of different other sensing element: Resistive sensing element (eg. Potentiometer), Capacitive sensing element (eg. Variable Separation, area and dielectric), Induction sensing elements (eg. Variable Reluctance), Electromagnetic sensing element (e.g. Velocity Sensors), Level Instrumentation Design.
8. Design of Signal Conditioning elements: Deflection Bridges, Amplifiers, AC. Carriers systems, Current Transmitters, Oscillation and Resonation.
9. Design aspects of signal processing elements and software
- Analog to Digital Conversion, Sampling, Quantisation, Encoding.
- Signal processing calculations, Steady State compensation, Dynamic Digital compensation and filtering.
10. Intrinsically Safe Measurement Systems:
- Pneumatic Measurement System: Flapper- Nozzle, Relay, Torque Balance Transmitters, transmission and data Presentation.
- Intrinsically Safe Electronic System: The Zener Barrier, Energy Shortage Calculation.
11. Instrumentation design: Classification of Instruments, Indication, Recorders, Monitors, Analysers, Dataloggers, and Controllers selection of instruments, General Design Consideration.
12. Control System Component Design: Control Valve and their Selection, Pumps, Motors, Transmission Schemes, Design of Control Panels, Design of Control Room layout, Flameproof design, Testing.
13. Comparison of Pneumatic, Hydraulic and Electrical/Electronic instrumentation systems and their selection for present process industry requirement.
14. Project Documentation, Specification Sheet, Index Sheet, Flow Diagram, Schedules used in typical process industry erection.
15. Testing, Erection, Commissioning of typical process industry.

Reference Books

1. B. G. Liptak, Instrument Engineers Handbook, Vol. I and II, Third Edition, Chilton and Book Company, 1990.
2. D. M. Considine, Process/Industrial Instruments and Control Handbook, Fourth Edition, McGraw-Hill Inc., 1993.
3. C. D. Johnson, Process Control Instrumentation Technology, Fourth Edition, PHI, 1996.
4. Andrew and Williams, Applied Instrumentation in Process Industries, Vol. I, II, III, IV, Gulf Publishing Company, 1979.
5. John P. Bentley, Principles of Measurement Systems, Addison-Wesley publication, 1999.
6. T. R. Padmanabhan, Industrial Instrumentation: Principles and Design, Springer-Verlag Publications, 1999.
7. B. C. Nakra and K. K. Choudhari, Instrumentation: Measurement and Analysis, Tata McGraw Hill Pub, 1985.

MIN532 Computer Process Control (4 Credits, L3-T0-P2)

Course Objective

This course is designed to M. Tech.- first year, second semester course considering that admitted students are from different branches like Instrumentation, electrical, electronics and electronics- telecommunications. This course is provided by the Department of Instrumentation Engineering. It is designed to achieve the following objectives:

1. Introduce basic fundamentals of Computer based process control.
2. To elaborate different concepts of process control, mathematical modelling of process dynamics.
3. Analysis and investigations of the basic computer control schemes starting from sampling to discrete systems, development of pulse transfer functions

4. To study stability of discrete control systems.
5. To make students familiar with different digital controllers and their design.
6. To introduce the students to advanced control strategies like adaptive control and others.

Course Outcomes

Upon successful completion of this course, a student should be able to:

1. Know the application of different computer process control systems.
2. determine the pulse transfer function of the zero order, first order holds
3. Be conversant with application of different digital controllers and their designs to suitable processes with or without time delay systems.
4. Know the advanced control concepts, system identification and process modelling.

Syllabus

1. Introduction to Process Control: Incentives for process control, Design aspect of process control systems, Process dynamics and mathematical models, Types of dynamic processes.
2. Computers in Process Control: Advantages, Implementation problems: Sampling, Quantization, Aspects of control theory: Transfer function approach, State space approach.
3. 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.
4. Closed Loop Response and Stability of Sampled Data Systems: Determination of closed loop transient response, Shur-Cohen-Jury Stability criterion.
5. 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.
6. Design of Digital Controllers: Digital approximation of classical controllers, Effect of sampling, Different class of digital controllers, Ringing and placement of poles, Design of optimal regulatory control systems, General synthesis method, Dahlin design, Kalman design, Predictive controller design, Internal-Model control.
7. Control of Time Delay Systems: Simulation of pure time delay systems, Smith's principle and method.
8. Design and Applications of Advanced Control Concepts: Process modelling and identification: Process modeling from step test data, pulse testing for process identification, Time domain process identification, Adaptive Control and Self Tuning: Gain scheduling, Model reference adaptive control, Self-tuning regulators, Feedforward Control: Introduction and design fundamentals, Some examples, Cascade Control: Controller design of cascade systems and industrial application, Multivariable Control Systems: Interaction analysis, Bristol's relative gain analysis, Singular value decomposition, Decoupling for non-interacting control, Model Predictive control.

Reference 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.

3. K. Warwick and D. Rees, Editors: Industrial Digital Control Systems, IEE Control Engineering Series, UK, 1986.
4. J. R. Leigh, Applied Digital Control, Theory, Design and Implementation, Prentice-Hall International, 1985.
5. G. Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, Prentice-Hall of India, 1998.
6. K. J. Astrom and B. Wittenmark, Computer Controlled Systems: Theory and Design, Second Edition, Prentice-Hall of India, 1994.

MIN533 Intelligent Instrumentation (4 Credits, L3-T0-P2)

Course Objective

1. To understand historical development of microcontrollers and to know different 8, 16, 32 bit microcontrollers.
2. To study block diagram of 8051, instruction set of 8051, use the instruction set for writing programs.
3. To get insight of 8051 based hardware system and so to study ADC, keyboard etc.
4. To understand historical development of PLC, SCADA, DCS
5. To study block diagram of PLC, instruction set of PLC, use the instruction set for developing ladder diagram programs for industrial applications.
6. To study SCADA software and actually develop mimics considering industrial applications
7. To know basics of hybrid DCS and develop some applications on the set up
8. To study basics of DCS and understand applications of DCS systems in industry.

Course Outcomes

Upon successful completion of this course, a student should be able to:

1. Know the basics of 8051 and programming of 8051
2. Design of dedicated card for different application based on 8051.
3. Know the basics of PLC and ladder diagram programming.
4. Know the basics of SCADA, developing mimics, basics of DCS and hybrid DCS

Syllabus

1. Introduction to Microcontrollers: 8051 or any 8-bit or 16-bit microcontroller, Architecture, Instruction set, Interfacing of microcontroller with ADC etc., Design of dedicated cards using microcontroller, Smart sensors.
2. Programmable Logic Controllers (PLC): Introduction. Architecture, discrete I/O systems, Analog I/O systems, definition of discrete state process control, discrete state variables, event sequence description Ladder diagram: Background, ladder diagram elements, ladder diagram symbols, development of ladder diagrams, Programming, advanced features and study of at least one industrial PLC.
3. Introduction to Supervisory control and data acquisition (SCADA).
4. Distributed Control System: Introduction and overview, History, System architecture, System elements, Data communication links. Difference between centralized and distributed control system, Overall tasks of digital control systems, Detailed task listing. Displays: Group display, Overview display, Detail display etc, Local control units, Mean time between failures.
   Data Highways, Field buses, Multiplexers and Remote Sensing Terminal units,
   I/O hardware, Set point stations,
5. Local area networks, Network protocols: MAP/TOP,.
6. Study of TDC-3000, ABB MOD 300, Yokogova Centum XL (At least one).

Case study (One).
7. Field buses
8. Introduction to Hybrid controllers

Reference Books

1. D. Popovic and Vijay Bhatkar: Distributed Computer Control for Industrial Automation, Marcel Dekker Inc., 1990.
2. M. Lucas: Distributed Control Systems.
3. B. G. Liptak, Instrument Engineer's Handbook, Process Control, Third Edition, Chilton Book Company, 1996.
4. C. D. Johnson, Process Control Instrumentation technology, Prentice- Hall of India, 1993.
5. C. L. Alberts and D. A. Coggan, Editors: Fundamentals of Industrial Control, ISA Publication, 1992.
6. Hughes: Programmable Controllers, ISA Publications, 1989.
7. Parr, Programmable Controllers: An Engineers Guide, Butterworh-Heinmen Limited, 1993.
8. K. J. Ayala, 8051 Microcontroller: Architecture, Programming and Applications, Penram International Publishing (India), 1996.
9. Garry Dunning, Introduction to Programmable controllers, 2nd Edition, Thomson Asia, Pte, Ltd, Singapore, 2002.

Elective II and Elective III

(A student will have to select any two elective subjects from following for part II)

MIN541 Optimal and Robust Control (4 Credits, L3-T0-P2)

Course Objectives

The course has three main objectives:

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

Course Outcomes

1. Design and implement system identification experiments.
2. Use input-output experimental data for identification of mathematical dynamical models.
3. Use singular value techniques to analyze the robustness of control systems.
4. Incorporate frequency-domain-based robustness specifications into multivariable control system designs.
5. Use H-infinity methods to design robust controllers.
6. Explain the advantages and disadvantages of robust control relative to other control approaches.

Syllabus

1. Linear Quadratic Control: The Linear Quadratic Regulator (LQR) problem: LQR solution using the minimum principle, Generalization of LQR; LQR properties with classical interpretations; Optimal observer design- Kalman-Bucy filter: Problem formulation and

Solution, The Linear Quadratic Gaussian (LQG) problem: Introduction, LQG problem formulation and solution, Performance and Robustness of optimal state feedback, Loop Transfer Recovery (LTR).
2. Robust/H_∞ Control: Introduction, Critique of LQG, Performance specification and robustness: Nominal performance of feedback system; Nominal performance: Multivariable case, Novel problem formulation of classical problem, Modeling uncertainty, Robust stability, Mathematical background: Singular Value Decomposition (SVD); Singular values and matrix norms; The supremum of functions, Norms and spaces, H_2 Optimization and Loop Transfer Recovery (LTR), 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.
3. Robust Control: The Parametric Approach: Stability theory via the boundary crossing theorem, The stability of a line segment, Interval polynomials: Kharitonov's theorem for real and complex polynomials, Interlacing and Image set interpretations, Extremal properties of the Kharitonov polynomial, Robust-state feedback stabilization, Schur stability of interval polynomials, The Edge theorem, The Generalized Kharitonov theorem, State space parameter perturbations, Robust stability of Interval matrices, Robustness using the Lyapunov approach, Robust parametric stabilization.

Reference Books

1. J. M. Maciejowski, Multivariable Feedback Design, Addison-Wesley Publishing Company, 1989.
2. H. Kwakernaak and R. Sivan, Linear Optimal Control Systems, Wiley-Interscience, 1972.
3. B. D. O. Anderson and J. B. Moore, Linear Optimal Control, Prentice-Hall, 1990.
4. S. P. Bhattacharya, H. Chapellat and L. H. Keel, Robust Control: The Parametric Approach, Prentice-Hall, PTR, NJ07458, 1995.
5. K. Zhou, J. C. Doyle and K. Glover, Robust and Optimal Control, Prentice-Hall, NJ07458, 1996.
6. J. Ackermann, Robust Control: Systems with Uncertain Physical Parameters, Springer-Verlag, London, 1993.
7. F. L. Lewis and V. L. Syrmos, Optimal Control, Second Edition, John Wiley and Sons, Inc. 1995.

MIN542 Fuzzy Based Control Systems (4 Credits, L3-T0-P2)

Course objectives

This course presents an overview of the theory and applications of fuzzy systems to engineering applications with emphasis on control. The objective of this course is on the understanding of various fuzzy systems models and the applications of these models to solve engineering problems. To cater the knowledge of Fuzzy Logic Control and use of these for controlling real time systems.

Course Outcomes

1. To teach about the concept of fuzziness involved in various systems. To provide adequate knowledge about fuzzy set theory.
2. To provide comprehensive knowledge of fuzzy logic control and adaptive fuzzy logic

3. To provide adequate knowledge of application of fuzzy logic control to real time systems.
4. Have a good understanding of the techniques for identification and control of the nonlinear processes
5. Have a good understanding of the techniques for designing successful applications
6. Gain hands-on experience with of using fuzzy logic for online process control applications

Syllabus

Unit -1
Introduction: Motivation, Fuzzy Systems, Fuzzy control from an industrial perspective, Uncertainty and Imprecision, Uncertainty in information, Chance Versus Ambiguity, The mathematics of fuzzy control.
Unit -II
Classical sets and fuzzy sets: Vagueness, Fuzzy set theory versus Probability theory, Operation and properties of classical and fuzzy sets.
Unit -III
Classical relations and fuzzy relations: Cartesian Product, Crisp relations, Fuzzy relations, Operations on fuzzy relations, Various types of binary fuzzy relations, Fuzzy relation equations, The extension principle and its applications, Tolerance and equivalence relations, Crisp equivalence relation, Crisp tolerance relation, Fuzzy tolerance and equivalence relation, Value assignments.
Unit -IV
Fuzzy logic and Approximate reasoning: Introduction, Linguistic variables, Fuzzy logic: Truth-values and truth tables in fuzzy logic, Fuzzy propositions. Approximate reasoning: Categorical, qualitative, syllogistic, dispositional reasoning, fuzzy If - then statements, Inference rules, The compositional rule of inference, representing a set of rule, Properties of a set of rule.
Unit -V
Fuzzy knowledge based controllers (FKBC) design parameters: Introduction, Structure of a FKBC, Fuzzification and defuzzification module, Rule base, Choice of variable and contents of rules, derivation of rules, data base, choice of membership function and scaling factors, choice of fuzzification and defuzzification procedure, various methods.
Unit -VI
Adaptive fuzzy control: Introduction, Design and performance evaluation, the main approaches to design self-organizing controller, Model based controllers.
Unit – VII
Neuro-fuzzy and fuzzy-neural control systems: Adaptive fuzzy systems, optimising the membership functions and the rule base of fuzzy logic controllers using neural networks, fuzzy transfer functions in neural networks, elements of evolutionary computation, case studies.

Reference Books

1. D. Drainkov, H. Hellendoorn and M. Reinfrank, An Introduction to Fuzzy Control, Narosa Publishing House, 1993.
2. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw Hill, Inc 1995.
3. H. J. Zimmermann, Fuzzy set theory and its applications, second edition, Allied Publishers limited, New Delhi, 1996.
4. T. Terano, K. Asai and M. Sugeno, Fuzzy systems theory and its application, Academic Press, 1992.

5. G. J. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall of India, New Delhi, 1997.

MIN543 Applied Nonlinear Control (4 Credits, L3-T0-P2)

Course Objectives

The goals of the course are:

1. To introduce students to nonlinear dynamical systems and phenomena with examples drawn from mechanical systems.
2. To provide methods of characterizing and understanding the behavior of systems that can be described by nonlinear ordinary deferential equations.
3. To provide the necessary methods for designing controllers for such systems.
4. To provide applications relevant to the mechanical engineering disciplines where the course material can be applied (aerospace control, vehicle control, process control, control of dynamical systems . . .)

Course Outcomes

1. Students can derive and describe the methods for PPA and DF
2. Students can apply the PPA and DF method to specific systems.
3. Students can derive and describe the feedback linearization
4. Students can apply the method of feedback linearization to specific systems

Syllabus

1. Introduction: Introduction to nonlinearities and non linear phenomenon, Nonlinear system behavior, Why nonlinear control?, Examples.
2. Phase Plane Analysis: Concepts of Phase Plane Analysis: Phase Portraits; Singular Points; Symmetry in Phase Plane Portraits, Methods of Constructing Phase Portraits: Analytical method, the method of Iscolines, Determining time form Phase Portraits, Phase Plane Analysis of linear systems, Phase Plane Analysis of nonlinear systems, limit cycles and existence of limit cycle: Poincare, Bendixsons theorem.
3. Describing Function Method: Describing function fundamentals: An example of describing functions; Computing describing functions, Derivations of describing functions of common nonlinearities, Describing function analysis of nonlinear systems: The Nyquist Criterion and its extension: Existence of limit cycles; Stability of limit cycles; Reliability of describing function analysis, Introduction to dual input describing functions, Subharmonic and jump resonance.
4. Fundamentals of Lyapunov Theory: Introduction, Nonlinear Systems and Equilibrium Points. Autonomous and Non-autonomous systems, Concept of Stability, Asymptotic stability and exponential stability, Local and global stability, Linearization and Local stability, Lyapunov's linearization method, Lyapunov's direct method, Positive definite functions, and Lyapunov's functions, Equilibrium Point theorems; Lyapunov theorem for local and global stability, Invariant set theorems, System Analysis based on Lyapunov Direct method. Lyapunov analysis of linear time-invariant systems, Generation of Lyapnov functions. Krasovski's Method, The variable gradient method Physically motivated Lypunov functions, control design based on Lyapunov's direct method.
5. Advanced Stability Theory: Concepts of stability for non-autonomous systems, Lyapunov analysis of Non-autonomous systems, Lyapunov like analysis using Barbalat's Lemma, Positive linear system: PR and SPR transfer functions, The Kalman - Yakubovich Lemma, The Passivity formulation.

6. Feedback Linearization: Intuitive concepts: Feedback linearization and canonical form; Input-state; Input-output linearization, Mathematical tools, Input-state linearization of SISO systems; Generating a linear input-output relation. Normal forms, The zero-dynamics. Stabilization and tracking; Inverse dynamics and Non-minimum phase systems; Case study: Trajectory Control of Robot Manipulator.

Reference Books

1. J. E. Slotine and w. Li, Applied Nonlinear Control., Prentice Hall Inc. Englewood cliffs, New Jersey 1995.
2. M. Vidyasagar, Nonlinear System Analysis, Prentice-Hall Inc. Englewood cliffs, New Jersey 1978.
3. Gelb A. and Vander Velde W. E., Multiple Input describing Function and Nonlinear System Design, Machrao-Hill (1968).
4. A. Isidori, Nonlinear Control System: An Introduction, Springer Yerlag, 1989.
5. Gibson, Nonlinear Automatic Control, Tata Ma-Graw Hill, 1963.

MIN544 Adaptive Control Systems (4 Credits, L3-T0-P2)

Course Objective

Applications of adaptive controls are growing in practical and industrial control systems. The objective of this course is to present an overview of theoretical and practical aspects of adaptive control. The theory of adaptive control techniques and related issues are covered in detail. On the other hand, course projects emphasize practical applications of adaptive controls.

Course Outcomes

Based on theoretical and practical knowledge on methods to develop mathematical models from experimental data; Adaptive control systems. After taking this course, the student should be able to:

1. Design and implement system identification experiments.
2. Use input-output experimental data for identification of mathematical dynamical models.
3. Use system identification methods to design adaptive controllers.
4. Explain the advantages and disadvantages of adaptive control relative to other control approaches.

Syllabus

1. Introduction: Definitions, History of adaptive Control, Essential aspects of adaptive control, Classification of adaptive control system: Feedback adaptive controllers, Feed forward adaptive controllers, Why adaptive control?
2. Model Reference Adaptive System: Different configuration of model reference adaptive systems; classification of MRAS, Mathematical description, and Equivalent representation as a nonlinear time-varying system, direct and indirect MRAS.
3. Analysis and Design of Model Reference Adaptive Systems: Model reference control with local parametric optimization (Gradient method), MIT rule, MRAS for a first order system, MRAS based on Lyapunov stability theory, Design of a first order MRAS based on stability theory, Hyperstability approach, Monopoli's augmented error approach.
4. Self Tuning Regulators: Introduction: The basic idea; process models, disturbance models, General linear difference equation models, model simplification, Different approaches to self-tuning, Recursive Parameter Estimation Methods: The RLS method,

extended Least squares, Recursive instrumental variable method; U-D factorization, Covariance resulting, variable data forgetting. Estimation accuracy, Direct and Indirect Self-tuning regulators, Clarke and Gawthrop's Self tuning Controller, Pole Placement approach to self tuning control; Connection between MRAS and STR.

5. Gain Scheduling: Introduction, The Principal, Design of Gain Scheduling Regulators, Nonlinear transformations, Applications of gain scheduling.
6. Alternatives to Adaptive Control: Why not Adaptive Control? Robust High gain feedback control, Variable Structure schemes,
7. Practical aspects, application and Perspectives on adaptive control.

References Books

1. I. B Landau, Adaptive Control - The Model Reference Approach, New York; Marcel Dekker, 1979.
2. K. J. Astrom and B. Wittenmark, Adaptive Control, Addison Wesley Publication Company, 1989.
3. B. Roffel, P. J. Vermeer, P. A. Chin, Simulation and Implementation of self Tuning Controllers, Prentice-Hall, Englewood cliffs, NJ, 1989.
4. R. Isermann, K. Lashmann and D. Marko, Adaptive Control Systems, Printice-Hall International (UK) Ltd. 1992.
5. K. S. Narendra and A. M. Annaswamy, Stable Adaptive Systems

MIN545 Estimation and Identification (4 Credits, L3-T0-P2)

Course Objectives

1. To get better understanding of the physical mechanism generating the signal (for example, speech signals).
2. To infer about some of the signal parameters. For example, a radar echo from a moving target contains information about the target motion.
3. To track changes in the signal's source and help identify their cause. For example, certain diseases affect the electrical signal generated by the human brain.
4. To predict the signal's future behavior. For example, a good probabilistic model of stock market behavior may help one to predict its future trends and take advantage of them.
5. To improve the quality of the signal (for example, reduction of noise and reverberation of a voice signal).
6. To achieve data compression for storage or transmission.
7. To synthesize artificial signals similar to the natural ones.

Course Outcomes

1. Knowledge of a variety of mathematical models for random phenomenon.
2. Ability to classify such models as to issues of stationary, Markovianness, kinds of asymptotic behavior, and sample function continuity and differentiability.
3. Ability to make optimal inferences and estimates with respect to such criteria as minimum error probability, and least mean square error (e.g., Wiener and Kalman filtering). Elements of optimal design are introduced.
4. Response of linear systems to random process inputs.
5. Be aware of common applications of such models to communication systems, sources of noise such as thermal noise, behavior of queues and particle emission systems.

Syllabus

1. Discrete Time Random Process: Random Variables Definitions, Ensemble Averages, Jointly Distributed Random Variables, Joint Moments Independent, Uncorrelated and Orthogonal random variable, Linear Mean Square, estimation, Gaussian Random Variables, Parameters Estimation- Definitions, Ensemble Averages, Gaussian Processes, Stationary Processes, the Covariance and autocorrelation matrices, Ergodicity, White Noise, the Power Spectrum, Filtering Ransom Processes, Spectral Realization, Special Types of Random Processes- MA, AR, ARMA, and Harmonic.
2. Linear Predication and Optimum Linear Filters- Rational Power Spectrum, Relationship between the Filter Parameters and the Autocorrelation Sequence, Forward and Backward Linear Prediction, Solution of the Normal, Equations- Levinson-Durbin Algorithm, the Shur algorithm, Properties of Linear-Prediction Error Filters, AR Lattice and ARMA Lattice Ladder filters, Wiener Filters for Filtering and Prediction- FIR Wener Filter, IIR Wener Filter, Noncausal Wener Filter.
3. Signal Modeling and System Identification:- System Identification based on FIR(MA), All-Pole (AR) and Pole-Zero (ARMA) Models- Pade Approximation, Prony's method, Shank's Method, Least-Square Filtering Design for Prediction and Deconvolution.
4. Solution for Least Sequences, Estimation Problems: - Definition and Basic Concepts, Matrix Formulation of Least Square Estimation Algorithm, Cholesky Decomposition, LDV Decomposition, QR Decomposition, Gram-Schmilt Orthogonalization, Givers Rotation, Householder's Reflection, Singular Valve Decomposition (SVD).
5. Power Spectrum Estimation: - Estimation of Spectra form Finite Duration Observations of Signals, Nonparametric Methods for Power Spectrum Estimation, Parametric Method for power spectrum estimation, Minimum variance spectral estimation, Eigen analysis algorithms for spectrum estimation.

Reference Books

1. Proakis J. G., Rander C. M., f. Ling and Nikins C. L., Advanced Digital Signal Processing, Macmillan Publishing Company, New York, 1992
2. Hayes M. H., Statical Digital Signal Processing and Modelling, John Wiley and Sons INC. New York, 1996.

MIN546 Digital Image Processing (4 Credits, L3-T0-P2)

<u>Course Objectives</u>

The objectives of this course are to:

1. Cover the basic theory and algorithms that are widely used in digital image processing
2. Expose students to current technologies and issues that are specific to image processing systems
3. Develop hands-on experience in using computers to process image.
4. Familiarize with MATLAB Image Processing Toolbox
5. Develop critical thinking about shortcomings of the state of the art in image processing.

<u>Course Outcomes</u>

1. Know and understand the basics and fundamentals of digital signal and image processing, such as digitization, sampling, quantization, and 2D-transforms
2. Operate on images using the processing techniques of smoothing, sharpening, enhancing, reconstructing geometrical alterations, filtering, restoration, segmentation, features extraction, compression, encoding and color /multichannel.

3. Manipulate images using the computer: reading, writing, printing, and operating on them.
4. Apply and relate the basic imaging techniques to practical cases, such as, multimedia, videoconferencing, pattern and object recognition, etc.
5. Aware of the ethical and legal issues related to image processing, such as, copyright, security, privacy, pornography, electronic distribution, etc
6. Train and encourage the students to present and discuss the computer assignments and projects to their classmates and on the web.

Syllabus

1. Introduction: Digital image representation, fundamental steps in image processing, elements of digital image processing systems, hardware for image processing system - Frame Graber, Characteristics of image digitizer, Types of digitizer, Image digitizing components, Electronic image tube cameras, solid state cameras, scanners.
2. Digital image fundamentals: Elements of visual perception, a simple image model sampling and quantization some basic relationship between pixels, image geometry, Basic transformations, Perspective transformation, Camera model and calibration, stereo imaging
3. Image transforms: 2-D Fourier transform, Fast Fourier transform, Other separable transforms, Walsh Transform, Hadamard Transform, Discrete Cosine Transform, wavelet Transform- Haar function, Gabor Transform, Hotelling transforms.
4. Image enhancement: - Enhancement by point processing, spatial filtering, enhancement in the frequency domain, Color image processing.
5. Image restoration: Degradation model, diagonalization of circulate and block-circulate matrices, algebraic approach to restoration, inverse filtering, least mean square (wiener) filter, constrained least squared restoration, invractive restoration.
6. Image compression: - Redundancies, image compression models, elements of information theory, error-free compression- variable length coding, bit plane coding, lossless predictive coding, lossy compression – predictive coding, transform coding, video compression, image compression standards- JPEG, MPEG.
7. Image Analysis: Segmentation - detection of discontinuities, edge linking and boundary detection, thresholding, region -oriented segmentation, Representation and description: Representation schemes, descriptors, regional descriptors, pattern and pattern classes, Classifiers.

Reference Books

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, Pearson Education Asia, 2002.
2. A. K. Jain, Fundamentals of Digital Image Processing, Prentice Hall of India Pvt Ltd, New Delhi, India, 1989.
3. K. R. Castleman, Digital Image Processing, Prentice-Hall International, 1996.

MIN547 Computational Methods of Optimization (4 Credits, L3-T0-P2)

Course Objectives

The goals of this course are for students to:

1. Understand basic models of computation and how to use them to analyze the efficiency of algorithms.
2. Understand the fundamentals of a computer’s architecture affect the performance of algorithms.

3. Understand basic programming paradigms and the tools for implementations using these paradigms.
4. Understand the data structures that are typically used in optimization algorithms.
5. Learn to use basic programming environments and tools.

Course outcomes

1. Understand *why* optimization is so hard.
2. Learn to convert written descriptions into optimization problems.
3. Learn to solve optimization problems using black-box software.
4. Understand many of the fundamental optimization algorithms, such as quasi-Newton methods and linear programming.
5. Learn about constrained optimization.
6. Understand why convex optimization is an important modern development

Syllabus

1. Introduction to Optimization: Engineering applications of optimization, Statement of an optimization problem, Classification of optimization problems, optimization techniques.
2. Linear Programming I: Simplex Method: Standard form of linear programming problem, Geometry of linear programming problem, Definitions and Theorems, Solution of a system of linear simultaneous equations, Motivation to the simplex method, Simplex algorithm, The two phases of the simplex method.
3. Linear Programming II: Additional Topics: Revised Simplex method, Duality in linear programming, Decomposition Principle, Sensitivity or post optimal analysis, Transportation problem.
4. Nonlinear Programming I: One Dimensional Minimization: Unimodal function, Elimination method, Interpolation methods.
5. Nonlinear Programming II: Unconstrained Optimisation Technique: Introduction, Direct search methods, Descent methods.
6. Nonlinear Programming III: Constrained Optimisation Techniques: Characteristics of a constrained problem, Direct methods, Indirect methods.
7. Dynamic Programming: Introduction, Multistage Decision process, Concept of suboptimization and principle of optimality, Computational procedure in dynamic programming. Linear Programming as a case of dynamic programming, Continuous dynamic programming
8. Introduction to Genetic Algorithms and its use in optimisation.

Reference Books

1. S. S. Rao, Optimization theory and applications, Second Edition, Wiley Eastern Limited, New Delhi, 1989.
2. M. Wagner, Principles of Operation Research, Second Edition, Tata McGraw hill, 1983.

MIN 505 Seminar-I and MIN534 Seminar II
1 Credits, L0-T0-P2 (Each)

The seminar should be on any topic having relevance with Instrumentation and control engineering. The same should be decided by the student and concerned teacher. Seminar work shall be in the form of report to be submitted by the student at the end of the semester. The candidate will deliver a talk on the topic for half an hour and assessment will be made by two internal examiners appointed by DPGPC, one of them will be guide. Usually the seminars should be related to dissertation topics.

Each of the courses shall have the term work/ sessional, which includes the design/ experiments/ software/ assignments etc. that will have one credit each. The evaluation for which will be separate, however on the grade card one course will include five credits out of which four credits are for course work and one credit will be for term work / sessional.

MIN 561 Dissertation Part I (0-0-22-22)

Dissertation shall consist of:
Research work done by the candidate in the areas related to the program, or
Comprehensive and critical review of any recent development in the subject, or
Design and/or development of a product related to the programme done by the candidate.

Following shall be the guidelines for evaluation of dissertation part I
Dissertation Part I shall consist of the following components (whichever applicable)

1. Extensive literature survey,
2. Data collection from R&D organizations, Industries, etc,
3. Study of the viability, applicability and scope of the dissertation
4. Detailed Design (H/W and S/W as applicable)
5. Partial implementation

A candidate should prepare the following documents for examination

1. A term paper in the format of any standard journal based on the work
2. A detailed report of the work done by the candidate related to dissertation

Every candidate should present himself (for about 30 min.) before the panel of examiners (which will evaluate the dissertation I for TW and Oral marks) consisting of

1. Head of Department
2. M. Tech. Coordinator or his nominee
3. All guides
4. At least two examiners from outside the department.

MIN 562 Dissertation Part II (0-0-22-22)

The dissertation shall be assessed internally by a panel of examiners (similar to the one in dissertation part- I) before submission to the Institute. The candidate shall submit the dissertation in triplicate to the Head of the institution, duly certified that the work has been satisfactorily completed. The Practical examination (viva-voce) shall consist of a defense presented by the candidate or his/her work in the presence of examiners appointed by the University one of whom will be the guide and the other an external examiner.