POST GRADUATE PROGRAMME

TITLE : *MASTER OF TECHNOLOGY (COMPUTERISED CONTROL AND BIOMEDICAL ENGINEERING)*

CURRICULA AND SYLLABI:

The department offers two specialisations namely Computerized Control and Biomedical Engineering. A student can choose one specialization and select the departmental electives from the offered courses.

Departmental Core Courses:
(22 Credits for Semester I and 17 Credits for semester II)

Semester	Code	Subject Title	L-T-P	Credits
I	MIN501	Process Instrumentation	3-1-2	5
	MIN502	Advanced Digital Signal Processing	3-1-2	5
	MIN503	Modern Control Theory	3-1-2	5
	MIN504	Biomedical Instrumentation	3-1-2	5
	MIN505	Seminar I	0-0-2	2
II	MIN531	Instrumentation System Design	3-1-2	5
	MIN532	Computer Process Control	3-1-2	5
	MIN533	Intelligent Instrumentation	3-1-2	5
	MIN534	Seminar II	0-0-2	2

L-Lecture, T-Tutorial, P-Practical

Departmental Electives with Specialization
(5Credits for Semester I and 10 Credits for semester II)

Specialization / Semester	Computerized Control (5 Credits for each Course)			Biomedical Engineering (5 Credits each Course)		
	Code	Subject Title	L-T-P	Code	Subject Title	L-T-P
I	MIN511	Probability, Statistics and Stochastic Processes	3-1-2	MIN521	Fiber Optics in Biomedical Instrumentation	3-1-2
	MIN512	Advanced Power Electronics	3-1-2	MIN522	Artificial Neural Networks	3-1-2
	MIN513	Neural Networks in Control Systems	3-1-2	MIN523	Bio Systems Modelling	3-1-2
II	MIN541	Optimal and Robust Control	3-1-2	MIN551	Principals of Tomographic Imaging	3-1-2
	MIN542	Fuzzy based Control Systems	3-1-2	MIN552	Biomedical Computations	3-1-2
	MIN543	Applied Nonlinear Control	3-1-2	MIN553	Advanced Digital Signal Processing	3-1-2
	MIN544	Adaptive Control Systems	3-1-2	MIN546	Digital Image Processing	3-1-2
	MIN545	Estimation and Identification	3-1-2	MIN554	Biomedical Analytical Instrumentation	3-1-2
	MIN546	Digital Image Processing	3-1-2	MIN555	Biomedical Informatics and Safety Design	3-1-2
	MIN547	Computational Methods of Optimisation	3-1-2			

Note: A student will have to select any one subject for semester I, and any two subjects for semester II from his/her specialization.

EXAMINATIONS

There would be two minor examinations during the semester each of 20 marks and one-hour duration.

The first minor examination would be at the end of 5^{th} week and the second would be at the end of 10^{th} week.

The concerned faculty may conduct third minor examination if he feels, as per the convenience of the students and faculty.

At the end of the semester I, and semester II there would be a major examination of 60 marks (two hour duration)

The distribution of weight age for each component shall be decided and announced by the Course Coordinator at the beginning of the course, subject to such stipulations as are given in the scheme of the teaching and examination for a given programme with a prior approval of PGPC.

Those courses which have practical component (Term work /Sessional) or which are completely practical (Term work /Sessional) in nature will be evaluated regularly during the regular schedule (50%). It also has midterm evaluation (25%) and the end term evaluation (25%). The practical grades shall appear separately on the grade card.

MIN 505 Seminar-I and MIN534 Seminar II
2 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.

Departmental Core Courses (Semester I)

MIN501 Process Instrumentation
5 Credits, L3-T1-P2

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.

Practcal : 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
5 Credits, L3-T1-P2

1. Fundamentals of DSP background and review discrete time random signals.
2. Quatisation 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

5 Credits, L3-T1-P2

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

5 Credits, L3-T1-P2

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

Electives For Computerized Control Specialization (Semester I)

MIN511 Probability, Statistics And Stochastic Processes

5 Credits, L3-T1-P2

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

5 Credits, L3-T1-P2

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)*, 2^{nd} 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

5 Credits, L3-T1-P2

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.

References :

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.

Electives for Biomedical Engineering Specialization (Semester I)

MIN521 Fiber Optics In Biomedical Instrumentation

5 Credits, L3-T1-P2

1. Introduction: Historical developments, the general system, and advantages of optical fiber communication.
2. Optical Fiber waveguides: Introduction, Ray theory transmission, and electromagnetic mode theory for optical propagation, Cylindrical fiber, Single mode fiber.
3. Transmission Characteristics of optical fibers: Introduction, Attenuation, Material absorption losses in silica glass fiber, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, mid -infrared and far infrared transmission, Dispersion, intra modal dispersion, inter modal dispersion, over all fiber dispersion, Dispersion modified single -mode fibers, polarization, nonlinear phenomena.
4. Optical Fibers and Cables: Introduction, Preparation of optical fibers, liquid-phase (melting) techniques, vapour-phase deposition techniques, fluoride glass fibers, optical fibers, optical fiber cables, stability of the fiber transmission losses, cable design.
5. Optical Fiber Connection: Joints and Couplers: Introduction, fiber alignment and joint loss, fiber splices, fiber connectors, expanded beam connectors, fiber couplers.
6. Optical sources: The laser: Introduction, basic concepts, optical emission from semiconductors, the semiconductor injection laser, injection laser structures, single frequency injection lasers, injection laser characteristics, injection laser to fiber coupling, non-semiconductor lasers, narrow line width and wave length tunable lasers, mid-infrared lasers. The light emitting diode: Introduction, LED power and efficiency, LED structures, LED characteristics, modulation.
7. Optical decoders: Introduction, device types, optical detection principles, absorption, quantum efficiency, responsively, long wave length cut off, semiconductor photodiodes without internal gain, semiconductor photodiodes with internal gain, mid-infrared photodiodes, phototransistors, photocondoctive detectors.
8. Direct detection receiver performance considerations; Introduction, noise, receiver noise, receiver structures, high performance receivers.

9. Optical fiber systems 1: Intensity modulation/direct detection: Introduction, the optical transmitter circuit, the optical receiver circuit system design considerations, digital systems, digital system planning considerations, analog systems, distribution systems, advanced multiplexing strategies, application of optical amplifiers.
10. Optical fiber systems 2: coherent: Introduction, basic system, detection principles, practical constraints, modulation formats, demodulation schemes, receiver sensitivities, single and multi carrier systems.
11. Optical fiber measurements: Introduction, fiber attenuation measurements, fiber dispersion measurements, fiber refractive index profile measurements, fiber cut off wave length measurements, fiber numerical measurements, fiber diameter measurements, mode-field diameter for single-mode fiber, reflectance and optical return loss, field measurements.
12. Application of optical fibers in biomedical instrumentation

Reference Books

1. John M. Senior, Optical Fiber Communications: Principles and Practice, Second Edition Prentice-Hall of India Private Limited, New Delhi, 1999.
2. Kao C.K, Optical Fiber Systems: Technology, Design and Applications, Tata McGraw Hill, 1986.

MIN522 Artificial Neural Networks

5 Credits, L3-T1-P2

1. Introduction to Neural Network: Introduction: Artificial intelligence, Soft computing tools, Neural network, Architecture, Developments in neural network; Properties of Neural Network: Generalization, Function Approximation. Potential Applications of Neural Networks
2. Fundamental Aspects of Neural Computing: Introduction to neural computing: Introduction, Components of a neuron, Input and output weight threshold, Weight factors, Internal thresholds, Transfer functions, Summary of neuron Anatomy, Topology of a neural computing Tools, Inhibitory or excitatory connections, Connection options, Multiple Hidden Layer; Introduction to Learning with Neural Network: Types of Learning, Checking the performance of the neural network, Stability and convergence.
3. Fundamentals of Error Back propagation learning: Introduction; Learning Rules; Multi layer Feedforward neural network; Generalized delta rule; Need of generalized delta rule; Requirements For Back propagation learning; Derivation of generalized delta rule; Flowchart for training of network using generalized delta rule; Algorithm for EBP; Difference in Delta and Generalized Delta learning rule; Learning factors; Training Errors; Data Normalization and Denormalization; Initialization of the weights; Selection of learning rate and momentum factor; Selection of proper activation function; Selection of number of hidden layers; Selection of hidden layer neurons; Generation and using the network learning curves.
4. Feedforward neural networks: Introduction; Analysis of pattern association networks, Analysis of pattern classification networks, Analysis of pattern mapping networks.

5. Feedback neural networks: Introduction; Analysis of linear autoassociative FF networks, Analysis of pattern storage networks: Pattern storage networks, the Hopfield model: Stochastic Networks and simulated annealing; Boltzmann Machine.
6. Neural networks applications in biomedical systems/Instrumentation: ANN based ECG Analysis, EMG Signal Analysis, ANN based expert system for ECG and EMG

References Books

1. B. Yegnanarayana, Artificial neural networks, Prentice Hall of India, Private limited, New Delhi, 1999.
2. J.M. Zurada, Introduction to Artificial Systems, Singapore: Info Access and distributions, 1992.
3. James A. Anderson, An introduction to neural networks, Prentice Hall of India, Private limited, New Delhi, 1999.
4. S. Haykin, Neural Networks: A Comprehensive Foundation, Macmillan College Publishing Company, 1994.

MIN523 Bio Systems Modelling

5 Credits, L3-T1-P2

1. Modelling of Physiological systems.
2. Black-box models versus detailed physical models
3. Review of control system theory. Digital techniques in analysis and modelling.
4. Frequency domain techniques, Discrete Fourier transforms, Spectral Analysis system identification.
5. Numerical simulation techniques in modelling.
6. Open loop system- Transfer function of sensory reports, eye movement control system noodles.
7. Closed loop control systems neuromuscular control and reflexes, regulation of the coronary circulation.
8. Stability criteria for closed loop system.
9. Current techniques in physiological signal analysis and system modelling.
10. Modelling of human organs practical case study, neural network overview, study, and development.

Reference Books

1. A Oppenheim, A. Willsky and I. Yong, Signals and Systems, Prentice Hall of India Pvt Ltd, New Delhi, India, 1987.
2. J. H. U. Brown and D. S. Gann, Engineering Principal in Physiology, Academic Press.
1. J. G. Webster, Medical Instrumentation: Application and Design, houghton-Mifflin Boston. 1987.

Departmental Core Courses (Semester II)

MIN531 Instrumentation System Design

5 Credits, L3-T1-P2

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

5 Credits, L3-T1-P2

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

5 Credits, L3-T1-P2

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.

Electives for Computerized Control Specialization (Semester II)

MIN541 Optimal And Robust Control

5 Credits, L3-T1-P2

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

5 Credits, L3-T1-P2

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

5 Credits, L3-T1-P2

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

5 Credits, L3-T1-P2

1. Introduction: Definitions, History of adaptive Control, Essential aspects of adaptive control, Classification of adaptive control system: Feedback adaptive controllers, Feedforward adaptive controllers, Why adaptive control?
2. Model Reference Adaptive System: Different configuration of model reference adaptive systems; classification of MRAS, Mathematical description, 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

5 Credits, L3-T1-P2

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 fo 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

5 Credits, L3-T1-P2

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

5 Credits, L3-T1-P2

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.

Electives for Biomedical Engineering Specialization (Semester II)

MIN551 Principles of Tomograhic Imaging

5 Credits, L3-T1-P2

1. Introduction to image processing and tomographic imaging
2. Algorithms for reconstruction with Nondiffracting Sources: Linear Integrals and projection, the Fourier Slice theorem, Kectnstruction algorithms for parallel projections, reconstruction from fan projections, fan beam reconstruction from a limited number of views, three dimensional reconstruction.
3. Measurement of Projection Data:- The Nondiffracting case: X-ray Tomography, Emission Computed Tomography, Ultrasonic Computed Tomography
4. Aliasing Artifacts and Noise in CT Images
5. Tomographyic Imaging with Diffracting Sources: Diffracting projections, Approximations kto the wave equation, the Fourier diffraction theorem, Interpolation

and a filtered backpropogation algorithm for differating sources, limitations; Evaluation of reconstruction algorithms, experimental limitations.

6. Algebraic Reconstruction Algorithms.:- Introduction, B-scan imaging, Reflection Tomography, Reflection Tomography with point Transmitter/receivers

Reference Books

1. Kak A. C. and Slaney M., Principles of Computerized Tomographic Imaging, IEEE Press, 1988.
2. Heman G.T., Imaging Reconstruction from Projections, Implementation and Application, Topic in Applied Physics, vol.: - 32, Springer-Verlog 1979.

MIN552 Biomedical Computations

5 Credits, L3-T1-P2

1. Computer in data collection: Introduction to computers, personal computers, various systems, Introduction to accession system. Computations in electric radiography and electroencephelography. Computations of time domain/ Frequency domain analysis/ Epilipsy/ feature extractia/ power spectrum analysis.
2. Medical Imaging: Computers in medical imaging, Computerized tomography, Ultra Sonography, Various imaging techniques, Computations, Applications, Analysis.
3. Imaging Techniquies: Various methods of imaging techniques their comparisons analysis, applications,
4. Expert Systems: Development of expert systems for diagnostic aid.

References Books

1. E. A. Short life, Computer Based Decision Making in Medicine MYCIN, American Elsevier, 1976.
2. P. Szolovits (ed.) Artificial Intelligence in Medicine, West View Press, Boulder Colordao, 1982
3. A. E. Patricle, Decision Making in medicine Methods and Applications Ho Ridda CRC Press.
4. Computers in Medicine.

MIN553 Advanced Digital Signal Processing

5 Credits, L3-T1-P2

8. Fundamentals of DSP background and review discrete time random signals.
9. Quatisation 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.
10. 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.

11. 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,
12. 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.

Reference Books

6. P. P. Vaidyanathan, Multirate filters and Filter banks, PH International, Englewood Cliffs, 1993.
7. Rabiner and Schafer, Multirate signal Processing, PH Inernational, Englewood Cliffs,
8. C. S. Burus, R. A. Gopinath, H. Guo, Introduction to Wavelets and Wavelet Transform, Prentice Hall Inc. 1998.

MIN554 Biomedical Analytical Instrumentation

5 Credits, L3-T1-P2

1. Review of basic components of analytical instrumentation- Calorimeter and Spectrophotometers-electromagnetic radiation, Beer-Lambborts law, absorption Instruments - calorimeters - spectrophotometers sources of error and calibration.
2. Infrared spectrophotometers- Infrared spectroscopy- basic components - types I.R. Spectrophotometry - sample handling techniques- FT - IR spectroscopy - calibration- Mass spectrometers, basic mass spectrometers- types-component resolution and application of mass spectroscopy- NMR spectrometers.
3. Chromatography -basics of gas chromatography - methods of measurement of peak areas - Liquid chromatography - types - aminoacid analysers. An introduction to Gel Permeation chromatography. Thermoelectric Methods: Thermogravimetric analysis-differential thermal analysis.
4. Electrochemical Instruments - electrochemical cell- types of electrodes - potentiometers - conductivity meters - polarographs - pH meters - principal of measurement - electrodes - selective- ion electrodes - chemically sensitive semiconductor devices - bio -sensors.
5. Blood Gas Analysers- What is blood gas analyser? - Necessity, Blood pH measurement, measurement of blood pCO_2, Calculated bicarbohnate, total CO_2 and base excess, Blood pO_2 measurement, Catheter tip electrode for measurement of pO_2, and pCO_2, A complete gas analyser, C0mmercially available blood gas analysers.

Reference Books

1. R. S. Khandpur, Handbook of Analytical Instruments, Tata Mc-Graw Hill Pub, 1993.
2. Willard, Meritt, Dean, Settle, Instrumental Methods of Analysis, C S B Pub, 1986.

MIN555 Biomedical Informatics and Safety Design
5 Credits, L3-T1-P2

1. Introduction to information technology, Biomedical Engineering information, Internet, Data bank, Hospital management. Information system analysis and techniques,.
2. Admission, discharges, patient history, medical records, idat, biling, inventory, drug storage, information system.
3. Methods of history recording, structuring of data bank, ECG, EEG data bank, data collection, storage analysis, various techniques.
4. Design of software for hospital requirements, and planning, case history and administration.
5. Design of software for diagnostic capabilities.
6. Hospital safety studies various cases, instruments, and analysis.
7. Design of software for hospital safety requirements.
8. Case safety studies, history records, analysis.
9. Hospital case studie4s, records, analysis,

References:
1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata Mc G. Hill Pub.,1987.
2. E. J. McCormick, Human factors in engineering, Tata McGraw Hill Pub.1957.
3. Indian Standards on ECG/EEG/V Ray.
4. S. Rao, Operation and Maintenance of Electrical Equipments, Media Lab. Mumbai.