# Department of Instrumentation Engineering
## Ph. D. Course work for candidates registered in 2009-2010 and 2010-2011 for Paper-3 and Paper-4

| Sr. No. | Registration No. | Name of the Candidate | Name of the Guide(s) | Subject of Ph. D. | Paper-3 | Paper-4 | Year of Registration |
|---|---|---|---|---|---|---|---|
| 01 | 2009PIN001 | Agnihotri Santosh Prabhakar | L. M. Waghmare | Instrumentation Engineering | Computer Process Control | Time Delay Systems | 2009 |
| 02 | 2009PIN002 | Deogire Aruna Dinesh | S. T. Hamde | Instrumentation Engineering | Biomedical Instrumentation | Biomedical Signals and Processing | 2009 |
| 03 | 2009PIN003 | Rane Vivek Sudhakar | S. T. Hamde | Instrumentation Engineering | Biomedical Instrumentation | Biomedical Signals and Processing | 2009 |
| 04 | 2009PIN004 | Kurundkar Sangeeta Vishwas | S. M. Joshi/ L. M. Waghmare | Electronics and Telecommunication Engineering | Mobile Ad Hoc Networks | Computer Networks | 2009 |
| 05 | 2010PIN001 | Gawande Jayanand Pralhad | R. S. Holambe | Instrumentation Engineering | Advanced Digital Signal Processing | Digital Image Processing | 2010 |
| 06 | 2010PIN002 | Madhe Swati Prashant | R. S. Holambe | Instrumentation Engineering | Advanced Digital Signal Processing | Digital Image Processing | 2010 |
| 07 | 2010PIN003 | Mohd. Abdul Muqeet | R. S. Holambe | Instrumentation Engineering | Advanced Digital Signal Processing | Digital Image Processing | 2010 |
| 08 | 2010PIN004 | Munje Ravindra Kacharu | B. M. Patre/ A. P. Tiwari | Electrical Engineering | Modern Control Theory | State-space approach to Reactor Control | 2010 |
| 09 | 2010PIN005 | Parvat Bhagsen Jagnnath | B. M. Patre | Instrumentation Engineering | Modern Control Theory | Applied Nonlinear Control | 2010 |
| 10 | 2010PIN006 | Hajare Vikas Dattatray | B. M. Patre | Instrumentation Engineering | Modern Control Theory | Computer Process Control | 2010 |
| 11 | 2010PIN007 | Patil Deepak Onkar | S. T. Hamde | Instrumentation Engineering | Biomedical Instrumentation | Biomedical Signals and Processing | 2010 |
| 12 | 2010PIN008 | Jadhav Sharad Pandurang | R. H. Chile/ S. T. Hamde | Instrumentation Engineering | Model Predictive Control | Computer Process Control | 2010 |

**The syllabus for paper-3 and paper-4 mentioned in the above table in front of candidate name is given below:**

### Advanced Digital Signal Processing (PIN001)

1. 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.
2. 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.,
3. 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. Wavelet transform and its relation to multirate filter banks, paraunitary PR filter banks.

4. 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.
5. 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.
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.


## Digital Image Processing (PIN002)

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.


## **Modern Control Theory** (PIN003)

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.

**State-space approach to Reactor Control** (PIN004)

**Introduction and Preliminary Concepts:** Components of a nuclear reactor, Neutron balance, Reactivity Control, Neutron Reaction Cross-sections, Fission rate & power, Prompt and Delayed neutrons, Neutron life time.

**Mathematical Modeling of Nuclear Reactors:** Neutron diffusion equation, Derivation of Point kinetics model for zero power operation, Linearization & representation into standard state space form, Controllability , Observability and stability properties, Step response of Nonlinear and linearized forms of Point kinetics model, Log rate and Reactor period.

**Internal Reactivity Feedback Effects:** Moderator, Coolant and Fuel Temperature dependent reactivity feedbacks, void/density dependent reactivity feedbacks, Fission product poisoning, xenon dependent reactivity feedbacks, Modeling of Internal Reactivity Feedback effects, Effect of Internal feedbacks on stability.

**Mathematical modeling of Large Reactors:** Limitations of point kinetics model, Space-time kinetics modeling principles, derivation of modal and nodal models, linearization and representation into standard form, incorporating internal feedback effects into space-time kinetics model, Controllability, observability and stability properties.

**Signals for Reactor Control:** Start-up, intermediate and power range instrumentation, Excore signals, Incore signals, Thermal power, Need and schemes for correction of neutronics signals with thermal signals.

**Reactor Control Design:** Control of total power and power distribution, Significance of feedback of total power, Log rate and linear rate, Design of State feedback control and observer.

**Mathematical Modeling of Plant:** Modeling of SG/SD level and pressure variations, Turbine and Condenser, Feed Control valves.

**References:**

1. J. J. Duderstadt, L. J. Hamilton, “Nuclear Reactor Analysis” John-Wiley and Sons, USA, 1975
2. Samuel Glasstone, A. Sesonske, “Nuclear Reactor Engineering” Vol. 1 and Vol. 2, CBS Publishers New Delhi, 2003.
3. W. M. Stacey, “Nuclear Reactor Physics”
4. Design Manual ‘Nuclear Instrumentation System’ of TAPS3 and 4 by NPCIL, India
5. Design Manual ‘Reactor Regulating System’ of TAPS3 and 4 by NPCIL, India
6. Design Basis Report ‘Primary Heat Transport System’ of TAPS 3 and 4 by NPCIL, India.
7. Research Papers of A.P. Tiwari and S. R. Shimjt (IEEE TNS, Annals of Nuclear Energy, SACI 2006)

**Applied Nonlinear Control** (PIN005)

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, 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. 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.
6. Sliding Mode Control: Examples of dynamic systems with sliding modes; Sliding modes in relay and variable structure systems Mathematical Background Differential equations with discontinuous right-hand sides; Regularization methods; Equivalent control method; Sliding existence conditions Design Methods: Decomposition into regular form; Eigenvalue placement Control under uncertain conditions; Chattering problems

**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.

## Computer Process Control (PIN006)

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.

**Biomedical Instrumentation** (PIN007)

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


**Biomedical Signals and Processing (PIN008)**

1. Basic Neurology: Nervous system, neuron, resting potential, biopotential, Nernst equation, electrical equivalents.
2. Electrical activity of the heart: Cardiac system, bipolar and unipolar lead system, Einthoven triangle, electrodes, electrocardiogram-normal and abnormal, exercise ECG, lead positioning, electrode positioning for Holter ECG recording, vector cardiography, signal conditioning and processing.
3. Electrical activity of neuromuscular system: muscular system, electrical signals of motor unit and gross muscle, human motor coordination system, electrodes, correlation of force and work, EMG integrators, signal conditioning and processing.
4. Electrical activity of the brain: Sources of brain potential, generation of signals, component waves, EEG recording electrodes, 10-20 electrode system, EEG under Grand mal and petit mal seizures, signal conditioning and processing.
5. Electrical signals from visual system: Sources of electrical signals in eye, generation of signals, electro-retinogram, eletro-occulogram.
6. Electrical signals from auditory system: Generation of cochlear potential and nature, evoked responses, auditory nerves, signal conditioning and processing.
7. Noise and interference in biomedical signals: Sources of noise in biomedical signal recordings, filtering techniques-active and passive filters, digital filtering, grounding and shielding.

8. Computer applications and Bio-telemetry: Real time computer applications, data acquisition, compression and processing, remote data recording and management.
9. Digital signal processing and data compression: Typical signal processing operations, time-domain operations, correlation and covariance, convolution, Digital filters: Smoothing filters, least square polynomial smoothing, windowing, FFT, DFT, and Decimation in time and decimation in frequency FFT program. Data compression techniques: Direct data compression methods, Tolerance-comparison data compression techniques, polynomial predictors: Zero order predictor (ZOP), First order predictor (FOP), Polynomial interpolation: Zero order interpolator ZOI and FOI. AZTEC, MAZTEC, TP, CORTES, FAN, SAPA, DPCM, Entropy coding method, Peak picking method, cycle-to-cycle compression technique, Huffman coding, EBP-ANN based technique: Data compression-retrieval performance indices.
10. Medical imaging: Diagnostic X-rays, CAT, MRI, thermography, ultrasonography, medical uses of isotopes, endoscopy.

**Reference Books:**


1. W. J. Jonkins, "Biomedical Digital Signal Processing", Prentice Hall of India, New Delhi.
2. G. F. Ihbar, "Signal Analysis and Pattern Recognition in Biomedical Engineering", John Wiley and Sons.
3. R.S. Khandpur , "Hand Book of Biomedical Instrumentation.", Tata Mcgraw Hill Publ.
4. H.K. Wolf and P.W. Macfarlane (Editors) , "Optimization of Computer ECG Processing.", North Holland Publishing Co., Amsterdam
5. Carr and Brown, "Biomedical Instrumentation."
6. M.J. Goldman, "Principles of Clinical Electrocardiography."


## Model Predictive Control (PIN009)

1. Introduction to Model Predictive Control: MPC Strategy, Historical Perspective, Industrial Technology, Outline of the Chapters
2. Model Predictive Controllers: MPC Elements, Prediction Model, Objective Function, Obtaining the Control Law, Review of Some MPC Algorithms, Basic Formulation of Predictive control, State Space Formulation
3. Multivariable Model Predictive Control Formulation: Continuous-time MPC, Continuous-time MPC with Constraints, Discrete-time MPC, Discrete-time MPC with Constraints
4. Constrained Model Predictive Control: Constraints and MPC, Constraints and Optimization, Revision of Main Quadratic Programming Algorithms, Constraints Handling , 1-norms
5. Fast Methods for Implementing Model Predictive Control: Piecewise Affinity of MPC, MPC and Multiparametric Programming.

**Reference books:**


1. E. F. Camacho and C. Bordons. *Model Predictive Control.* Springer, New York, 2004.
2. B.W. Bequette. *Process Control: Modeling, Design and Simulation*. Prentice Hall (2003).
3. J.M. Maciejowski, Predictive Control with constraints,

## Mobile Ad Hoc Networks (PIN010)

1. Overview of Networking:
   Computer Networks, Cellular Wireless Networks, Mobile Ad Hoc Networks, Wireless Sensor Networks.
2. Introduction to Mobile Ad Hoc networks:
   Properties, features, challenges, QoS constraints/requirements, self configuring, self organizing, and self healing schemes.
3. Routing in Mobile Ad Hoc Network:
   Challenges, properties, broad classification and comparison, limitation of traditional routing approaches, criterion for performance evaluation of MANET routing protocols-such as mobility factors, wireless communication factors, security issues etc.
4. Mobility Management in MANETS:
   Positive impacts of mobility, Mobility models, classification, impact of mobility models on the performance of Wireless networks, radio wave propagation model.
5. Quality Of Service support in Mobile ADHOC networks:
   Challenges, factors affecting QoS performance protocol, QoS models, QoS MAC protocol, QoS routing mechanism, and protocols.

**References:**


1. Sudip Misra, Isac Woungang, Subhas Chandra Misra, "Guide to Wireless Adhoc Network," Springer.
2. Jagannathan Sarangpani, "Wireless Ad Hoc and Sensor networks:Protocols, performance and Control," CRC Press
3. Carlos De Morais Cordeiro, Dharma Prakash Agrawal, "Ad Hoc and Sensor Networks:Theory and applications,".


## Computer Networks (PIN011)

1. Introduction
   Introduction, Network Hardware, Software, Reference Model, Internet, Physical Layer, Transmission Media, Wireless Transmission, Switching - circuit switching, Packet switching, message switching.
2. Data Link Layer
   Data Link Layer design issues, Error detection and correction, Elementary Data link protocols, Sliding Window protocols, Data link layer in HDLC.
3. MAC Sublayer
   Medium access layer, Channel allocation problem, Channel allocation methods – TDM, FDM, ALOHA, Carrier sense multiple access protocols, collision free protocols – IEEE standard 802 for LAN, Ethernet, Wireless LAN, Bluetooth.
4. Network Layer
   Network Layer, design issues, Routing Algorithms , internetworking, fragmentation, network layer in Internet – IP protocols, IP address, subnets, internet control protocols, OSPF, BGP, internet multicasting, mobile IP.
5. Transport Layer
   The Transport Layer – Elements of transport protocols – addressing, establishing a connection, realizing connection, flow control and buffering and crash recovery, END to END PROTOCOLS – UDP, reliable byte stream (TCP).
6. Application Layer

Application Layer – Network security – cryptographic algorithms, Name Service (DNS), Domain Hierarchy, Name servers, Name resolutions, Traditional Applications – FTP, Telnet, SMTP, World wide web – HTTP, Network Management – SNMP.

**Reference Books:**


**1.** Andrew Tenenbaum, 'Computer Networks', Prentice Hall, 3rd and 4th Edition

**2.** Behrouz A. Forouzan, 'Data Communications and Networking', McGraw Hill, 4th Edition

**3.** William Stallings, 'Computer Networks', Prentice Hall.

**4.** Kurose & Ross, 'Computer Networking: A Top-Down Approach Featuring the Internet', Addison Wesley.


## Time Delay System (PIN012)

**1.** Introduction to Time Delay system :
What Is a Delay, Examples of Time-delay Systems, Controller Design: Classical Control of Time-delay Systems ,PID Control, Structure of PID Controllers, Tuning Methods for PID Controllers, Smith Predictor (SP)-based Control, Control Difficulties Due to Delay, Smith Predictor, Robustness, Disturbance Rejection, Modified Smith Predictor (MSP)-based Control, Modified Smith Predictor, Zero Static Error, Finite-spectrum Assignment (FSA), Connection Between MSP and FSA, Stabilising Controllers for Delay Systems, Predictor–Observer Representation: MSP, Observer–Predictor Representation: FIR Operators, Chain-scattering Approach, Representations of a System: IOR and CSR, Linear Fractional Transformations: The Standard LFT and the HMT, Some Important Properties, State-space Operations on Systems, Operations on Systems, Similarity Transformations, Algebraic Riccati Equations, Definitions, Stabilizing Solution, Block-diagram Representation, Similarity Transformations and Stabilising Solutions, Rank Defect of Stabilising Solutions, Stabilising or Grouping, The $\Sigma$ Matrix , Definition of the $\Sigma$ Matrix, Important Properties of $\Sigma$, The L2[0, $h$]-induced Norm

**2.** J-spectral Factorisation of Regular Para-Hermitian:
Transfer Matrices: Introduction, Properties of Projections, Regular Para-Hermitian Transfer Matrices, $J$-spectral Factorisation of the Full Set, Via Similarity Transformations with Two Matrices, Via Similarity Transformations with One Matrix, $J$-spectral Factorisation of a Smaller Subset, $J$-spectral Factorisation of $\Lambda = G{\sim}JG$ with Stable $G$, Contents xi, Numerical Examples

3. The Delay-type Nehari Problem:
Introduction, Problem Statement (NPh), Solution to the NPh , Proof, Special Cases, The Stable Case, The Conventional Nehari Problem, The Conventional Nehari, Problem with Stable $A$ , Realizations of $\Theta-1$ and $\Theta$, $J$-spectral Co-factor of $\Theta-1$, A Numerical Example, The Stable Case ($a < 0$), The Unstable Case ($a > 0$), Summary and Notes, An Extended Nehari, Problem, Problem Statement, The Solvability Condition, Solution, Proof, Rationalisation by $Z1$, Completing the $J$-losslessness , Realization of $M$

4 The Standard $H\infty$ Problem:
Introduction, Problem Statements, The Standard $H\infty$ Problem (SPh), The One-block Problem (OPh), Reduction of the Standard Problem (SPh), The Standard Delay-free $H\infty$ Problem (SP0), Reducing SPh to OPh, Reducing OPh to ENPh, Solutions, Solution to OPh, Solution to SPh,, Recovering the Controller, Realization of $V-1$ , A

Transformed Standard $H\infty$ Problem, Introduction, The Transformation, Solution, Numerical Example

5. 2DOF Controller Parameterisation:
   Parameterisation of the Controller, Two-degree-of-freedom, Realization of the Controller, Control Structure, Set-point Response, Disturbance Response, Robustness Analysis, Ideal Disturbance Response, Realization of $P1 - N \tilde{Y} P$, Application to Integral Processes with Dead Time, Unified Smith Predictor: Introduction, Predictor-based Control Structure, Problem Identification and the Solution, A Numerical Problem with the MSP, The Unified Smith, Predictor (USP), Control Systems with a USP: Equivalent Diagrams, Applications, Parameterisation of All Stabilising Controllers, The $H2$ Problem, A Transformed $H\infty$ Problem,
6. Controller Implementation:
   Discrete-delay Implementation of Distributed Delay in Control Laws, Introduction, A Bad Approximation of Distributed Delay in the Literature, Approximation of Distributed Delay, Approximation in the *s*-domain via the Laplace Transform, Direct Approximation in the *s*-domain, Equivalents for the Backward Rectangular Rule, Implementation of Distributed Delay *Z*, Implementation of *Z* in the *z*-domain, Implementation of ZOH in the *s*-domain, Implementation of *Z* in the *s*-domain, Stability Issues Related to the Implementation, Numerical Examples, Approximations and Implementations of Distributed Delay, System Responses using Different Implementations, Numerical Integration Using the Improved, Rectangular Rules, Rational Implementation Inspired by the $\delta$-operator, Introduction , The $\delta$-operator, An Initial Approximation, Implementation with Zero Static Error, Convergence of the Implementation, Structure of the Implementation, Numerical Examples

**Text Books**


1. "Robust Control of Time-Delay System" Qing-Change Zhong, Springer 1st Edition, 2006.
2. "Control System", Les Frnical, CENGAGE Learning, India. 1st Edition.


**References**


1. "Optimization Methods in Operations and Research Systems Analysis", K. V. Mital and C. Mohan, 1st Edition , New Age International Publications
2. "Optimization Concepts and Applications in Engineering", A. D. Belegundu and T. R. Chandrupatla, Pearson Education, 2002
3. "Control System Design Guide – A Practical Guide", George Ellis, USA, Academic Press, 3rd Edition, 456 pages, 2000
4. "Dynamic Modeling and Control of Engineering Systems", J. Lowen Sheaser, Bohan T. Kulawski Macmillan Publishing Company NY, 158275, 1990 Edition