B.Tech. DEGREE

INSTRUMENTATION AND CONTROL ENGINEERING

SYLLABUS

FOR

CREDIT BASED

CURRICULUM

(For students admitted in **2005**)

DEPARTMENT OF INSTRUMENTATION AND CONTROL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY

TIRUCHIRAPPALLI - 620 015

INDIA

SEMESTER - III

CODE	COURSE OF STUDY	L	T	P	C
MA209	Linear Algebra & Statistics	3	1	0	4
IC 201	Sensors and Transducers	3	0	0	3
IC 203	Circuit Theory	3	0	0	3
IC 205	Electron Devices	3	0	0	3
CE 283	Thermo Dynamics and Fluid Mechanics	4	0	0	4
MT 211	Material Science	3	0	0	3
CE 285	Thermo Dynamics and Fluid Mechanics Laboratory	0	0	3	1
IC 207	Circuits and Devices Laboratory	0	0	3	1
	Total	19	1	6	22

SEMESTER - IV

CODE	COURSE OF STUDY	L	T	P	C
MA202	Numerical Methods	3	0	0	3
IC 202	Signals and Systems	3	0	0	3
IC 204	Industrial Instrumentation	3	0	0	3
IC 206	Analog Electronic Circuits	3	0	0	3
IC 208	Digital Techniques	3	1	0	4
IC 210	Data Structures & Algorithms	3	1	0	4
IC 212	Sensors and Transducers Laboratory	0	0	3	1
IC 214	Electronic Circuits Laboratory	0	0	3	1
	Total	18	2	6	22

SEMESTER - V

CODE	COURSE OF STUDY	L	T	P	C
IC 301	Electrical and Electronic Measurements	3	0	0	3
EC 317	Principles of Communication Systems	3	0	0	3
IC 303	Microprocessors and Microcontrollers	3	0	0	3
IC 305	Linear Integrated Circuits	3	0	0	3
IC 307	Programming Tools & Techniques	3	1	0	4
IC 309	Control Systems	3	0	0	4
IC 311	Linear Integrated Circuits Laboratory	0	0	3	1
IC 313	Microprocessor and Micro-controllers Lab	0	0	3	1
	Total	18	2	6	22

SEMESTER - VI

CODE	COURSE OF STUDY	L	T	P	C
IC 302	Modern Control Theory	3	0	0	3
IC 304	Process Control	3	0	0	3
IC 306	Product Design and Development	3	0	3	4
IC 308	Personal Computers and Interfacing	3	0	0	3
IC 310	Computer Networks	3	0	0	3
IC 312	Personal Computers & Interfacing Lab	0	0	3	1
IC 314	Control Engineering Laboratory	0	0	3	1
IC 35X	Elective – 1	3	0	0	3
	Total	18	1	9	21

SEMESTER - VII

CODE	COURSE OF STUDY	L	T	P	C
IC 401	Logic and Distributed Control Systems	3	0	0	3
IC 403	Analytical Instrumentation	3	0	0	3
HM 401	Industrial Economics	3	0	0	3
IC 405	Biomedical Instrumentation	3	0	0	3
IC 407	Instrumentation Laboratory	0	0	3	1
IC 409	Process Control Laboratory	0	0	3	1
IC 447	Comprehensive Examination	0	0	0	3
IC 45X	Elective - 2	3	0	0	3
IC 45X	Elective - 3	3	0	0	3
	Total	18	0	6	23

SEMESTER - VIII

CODE	COURSE OF STUDY	L	T	P	C
IC 402	Opto-Electronics and Laser based Instrumentation	3	0	0	3
MB 790	Management Concepts & Practices	3	0	0	3
IC 45X	Elective – 4	3	0	0	3
IC 45X	Elective – 5	3	0	0	3
IC 498	Project Work	0	0	0	6
	Total	15	0	0	18

The total minimum credits required for completing the B.Tech. programme in Instrumentation and Control Engineering is 128 + 45 = **173.**

ELECTIVE LIST

CODE	COURSE OF STUDY	L	T	P	C
Elective - 1:					
IC 352	Power Electronics	3	0	0	3
IC 354	Micro Electro-Mechanical Systems	3	0	0	3
Electives – 2 & 3:					
IC 451	Embedded Systems and RTOS	3	0	0	3
IC 453	Virtual Instrumentation	3	0	0	3
EC 451	ARM System Architecture	3	0	0	3
EC 453	Digital Image Processing	3	0	0	3
CS 451	Principles of Cryptography	3	0	0	3

-> Any one elective from other department electives can be taken.

Electives – 4 & 5:					
IC 452	Power Plant Instrumentation and Control	3	0	0	3
IC 454	Smart Materials	3	0	0	3
EC 356	VLSI Systems	3	0	0	3
EC 464	Display Systems	3	0	0	3
CS 364	Network Multimedia Systems	3	0	0	3

-> Any one elective from other department electives can be taken.

RESERVE ELECTIVE LIST

CODE	COURSE OF STUDY	L	T	P	C
EE 352	Power Generation System	3	0	0	3
EC 354	Speech Processing	3	0	0	3
HM 352	Corporate Communication	3	0	0	3
IC 455	Optimization Technique	3	0	0	3
IC 457	Digital Control Systems	3	0	0	3
IC 459	Robotics	3	0	0	3
IC 461	Nano Technology	3	0	0	3
IC 456	Fault Detection and Diagnosis	3	0	0	3
IC 458	Automotive Control Systems	3	0	0	3
IC 460	Neural Networks, Fuzzy Logic, and Control	3	0	0	3
IC 462	Piping and Instrumentation Diagrams	3	0	0	3
IC 464	Reliability and Safety Engineering	3	0	0	3
	Biotechnology	3	0	0	3

-> For VI, VII and VIII semester, electives given may be replaced by appropriate course depending on the student strength from the general electives.

SUBJECTS OFFERED TO OTHER DEPARTMENTS

IC 301	Electrical and Electronic Measurements
IC 216	Instrumentation and Control
IC 218	Instrumentation and Control Lab
IC 306	Product Design and Development
IC 315	Mechatronics
IC 317	Mechatronics lab
IC 411	Instrumentation
IC 413	Instrumentation lab

MA209 LINEAR ALGEBRA AND STATISTICS

Linear Algebra and Matrices – Vector spaces, Subspaces, Basis and Dimension - Systems of Linear Equations.

Linear Transformations - Kernel and Image - Geometric Ideas - Inner Product spaces - Orthogonality - Orthonormal basis - Reflections and Orthogonal maps of the plane - Orthogonal complements and Projections.

Bilinear, Quadratic, Hermitian, and Skew-Hermitian forms - Eigenvalues and Eigenvectors - Cayley-Hamilton theorem - Change of basis and diagonalization.

Probability – Axioms of probability – Conditional Probability - Bayes' theorem – Random variable – Density and distribution functions – Expectation – Jointly distributed random variables – Marginal and Conditional Densities.
Binomial, Poisson and Normal distributions, Moment generating function, Characteristic function - Chebyshev's inequality - Law of large numbers.

References.

1. HOFFMAN, K., and KUNZE, R., Linear Algebra, Prentice Hall of India.

2. KREYSZIG, E., Advanced Engineering Mathematics, John Wiley.

3. KUMARESAN, S., Linear Algebra: A Geometric Approach, Prentice Hall of India.

4. ROSS, S.M., Introduction to Probability and Statistics for Engineers and Scientists, Elsevier.

IC 201 SENSORS AND TRANSDUCERS

General concepts and terminology of measurement systems, transducer classification, general input-output configuration, static and dynamic characteristics of a measurement system, Statistical analysis of measurement data.

Elastic sensing elements: Diaphragms, bellows, bourdon tubes, beam and column type elements, ring type elements, their construction and design features. Variable resistance transducers: Potentiometers, metal and semiconductor strain gauges and their signal conditioning circuits, strain gauge applications: Load and torque measurement.

Inductive transducers: Transformer type, synchros and resolvers, eddy current transducers, electromagnetic sensors, Hall effect sensors, proximity detectors, magnetostrictive transducers and capacitive transducers, tacho generator, stroboscope.

Piezoelectric transducers and their signal conditioning, digital displacement sensors, electro-kinetic transducers, photoelectric transducers, basics of gyroscope, seismic instrument and accelerometers.

Semiconductor sensor: Introduction, classification, and basic fabrication techniques.

Text Books:

1. John P. Bentley, "*Principles of Measurement Systems*", 3rd Edition, Addison Wesley Longman Ltd., UK, 2000
2. Doebelin E.O, "*Measurement Systems - Application and Design*", 4th Edition, McGraw-Hill, New York, 1992.
3. S.M. Sze, "*Semiconductor sensors*", John Wiley & Sons Inc., Singapore, 1994.

Reference Books:

1. Murthy D. V. S, "*Transducers and Instrumentation*", Prentice Hall, New Delhi, 1995
2. Neubert H.K.P, "*Instrument Transducers - An Introduction to their Performance and Design*", 2nd Edition, Oxford University Press, Cambridge, 1999.
3. Patranabis, "*Sensors and Transducers*", 2nd Edition, Prentice Hall India Pvt. Ltd., 2003.

IC 203 CIRCUIT THEORY

Circuit Analysis Techniques: Lumped circuits, Models of physical systems, Circuit elements, Network topology, Element and Circuit rules, Source transformations, Star-Delta Transformations, Nodal analysis, Mesh analysis, Principle of linearity, Network theorems and applications, Circuits with controlled (dependent) sources.

Sinusoidal Response: Behaviour of elements with sinusoidal signals, Impedance and admittance, Circuit analysis using phasors, Sinusoidal steady state response of circuits, Magnitude and phase, Power and energy, Power calculations, Three-phase circuits and power systems, Resonance, Solution of A.C. steady state network equations using complex frequency concept.

Transient Response: Application of Laplace transforms to circuit analysis, Circuits with capacitors, Circuits with inductors, Time-constant, Free and Step response of RC, RL, and RLC circuits.

Generalized Frequency Response: Mutual inductance, coefficient of coupling, ideal transformer. Inductively coupled circuits, tuned circuits, Impedance matching, one- port and two- port networks, impedance and admittance parameters, hybrid parameters, ABCD parameters, image impedance. State variables, The transfer function, Network functions - poles and zeros of network functions, Complex Frequency, scaling Network functions, Analysis of ladder network.

Causality, Stability, Realizability of one port networks, Hurwitz polynomials, positive real functions, Reciprocal and symmetric networks, Conditions for existence of networks, Network Synthesis: Properties of RC, RL, and LC driving point functions, Synthesis of networks from given transfer functions.

Text Books:

1. Hayt,W.H. and Kemmerly,J.E., "*Engineering Circuit Analysis*", McGraw Hill, New York, 5th edition, 1993.
2. Joseph,A.Edminister, "*Electric Circuits – Schaum's outline series*", McGraw Hill International, 3rd edition, 1997.
3. Ramakalyan, A., "*Linear Circuits: Analysis & Synthesis*", Oxford Univ. Press, India, 2005.

Reference Books:

1. Van Valkenburg, "*Network Analysis*", 3rd Edition, Prentice Hall, New Delhi, 1998.
2. D.Roy Chaudhry, "*Networks and Systems*", New Age International Publishers, New Delhi, 1997.
3. DeCarlo, R.A., & Lin, "*Linear Circuit Analysis*", 2nd Edition, OUP Indian Edition 2003.

IC 205 ELECTRON DEVICES

Semiconductor: Different semiconductor materials. Impurity doping. Intrinsic and extrinsic semiconductors. Conductivity, Carrier concentration. Charge densities. Kronig – penny model. E-K relation. Fermi level in semiconductors. Diffusion. Carrier life time. Continuity equation. Hall effect and its applications.

P-N junction diodes: P-N junction diodes, Contact potential, Current components, Forward and reverse biased junctions, V-I characteristics, Equivalent circuits. Transition and diffusion capacitance. SPICE diode model, Metal semiconductor contacts. Hetero junctions. Zener diodes, Schottky diode, Photo diode, LED. Varactor diode. Breakdown diodes. Transferred electron devices. Hot electron devices.

BJTs: Basic BJT theory, Different modes of operation and configurations. Transistor current components. Ebers – Moll model and Gummel – Poon model of BJTs. Transistor α, Current amplification β. Bipolar transistor switch, SPICE BJT model, Punch through and other breakdown mechanisms, Photo-voltic effect, Photo-cell transistors.

MOSFETs: Device structure and physical operation, Current – voltage characteristics, MOSFET circuits at DC, MOSFET as an amplifier and as a switch, Small signal model, MOSFET internal capacitance and high frequency model, Depletion type MOSFET, SPICE MOSFET model, CMOS structure, operation, BiCMOS operation, CCDs.

Power devices: Thyristor family – UJT, SCR, TRIAC, DIAC – operation and VI characteristics. Triggering. Power diodes, power transistors, IGBTs and GTOs fabrication and V-I characteristics.

Text Books:

1. S.M.Sze, "*Semiconductor Devices, Physics and Technology*", 2nd Edition, Wiley, 2002.
2. A.Bar-Lev, "*Semiconductor and Electronic Devices*", 3rd Edition, PHI, 1993.
3. L.Macdonald and A.C.Lowe, "*Display Systems: Design and Applications*", John Wiley and Sons, 2003.

Reference Books:

1. D.A.Neamen, "*Semiconductor physics and devices*", 2nd Edition, Irwin, 1997.
2. B.G.Streetman, "*Solid state devices*", 4th Edition, PHI, 1995.
3. D.A.Pucknell & K.Eshraghian, "*Basic VLSI Design*", 3rd Edition, PHI, 1996.

CE 283 THERMO DYNAMICS AND FLUID MECHANICS

Basic concepts: Thermodynamic equilibrium, quasi-static process, zeroth law, work and heat interactions, first law for a cycle and a process, steady flow processes, second law statements, reversibility, Carnot theorem, Clausius inequality, entropy principle.

Available energy: Availability and irreversibility, properties of pure substances, phase equilibrium diagrams, Rankine cycle, reheat and regenerative cycle, properties of ideal gas, Stirling and Ericson cycles.

Heat engines: Otto, diesel and dual cycles, Brayton cycle with regeneration, inter cooling and reheat, Joule-Thompson effect. Classification of fluids and their physical properties, Fluid statics, manometers, pressure on submerged bodies.

Ideal fluid – velocity field – stream line, streak line and path line, continuity equation – Rotational and irrotational motion, stream function and potential function, Eulers equations of motion, Bernoulli's equation and its application. Classification of open channel flows – measurement of discharge using rectangular and V notches.

Dimensional analysis – Rayleigh's method – Buckinghan π Theorem and its applications. Laminar flow – Losses – Hagen-Poiseuille equation - Turbulent pipe flow – friction Darcy weisbach equation – moody's diagram, minor losses – Boundary layer and its basic concepts.

Reference Books:

1. Van Wylen,G.A.,etal, "*Fundamentals of classical Thermodynamics*", 4th Edition, John Wiley & Sons, 1994.
2. Cengal,Y.A., Bogles,M.A., Micheal Boles, "*Thermodynamics*", 2nd Edition, McGraw Hill Book Company, 1994.
3. Nag,P.K., "*Engineering Thermodynamics*", 2nd Edition, Tata McGraw Hill, 1994.

MT 211 MATERIAL SCIENCE

Introduction to crystal structure of materials: Miller indices, X-ray diffraction techniques, mechanical properties of materials, elastic, viscoelastic and plastic behaviour, stress-strain relationship, relaxation creep, strengthening mechanisms and fracture.

Defects in solids: Point, line and planar defects and their effect on different planar properties of materials, phase diagram, mono component and binary systems, non - equilibrium phase diagrams and their applications.

Properties of materials: Thermal properties, specific heat, expansion, conductivity and application of these properties in selection of materials. Electrical properties, free electron theory, conductors and insulators, superconductors.

Properties of materials: Electronic properties, semiconductors, band theory, Fermi Dirac statistics, dielectric polarisation, dielectric constant and loss measurements. Magnetic properties, diamagnetic, paramagnetic, ferro magnetic, anti-ferromagnetic, ferromagnetic materials and their applications.

Optical properties of materials: Absorption and emission, losses, environmental effect on materials. Synthesis and growth of Group III - V compounds and their applications. Selection of specific materials required for instrumentation devices, valves, pipelines and coatings.

Text Books:

1. Smith, W.F, "*Foundations of Materials Science and Engineering*", 2nd Edition, McGraw Hill, New York, 1993.
2. Van Vlack, L.H, "*Elements of Materials Science and Engineering*", 6th Edition, Addison - Wesley, Singapore, 1989.
3. Raghavan V, "*Materials Science and Engineering - A first course*", 4th Edition, Prentice Hall, New Delhi, 1998.

Reference Books:

1. Anderson J.C, Leaver K.D, Rawlings R.D. and Alexander J.M., "*Materials Science*", 4th Edition, Chapman & Hall, London, 1992.
2. Askeland D.R, "*The Science and Engineering of Materials*", 2nd Edition, Chapman and Hall, London, 1989.
3. Callister W.D, "*Materials Science and Engineering: An Introduction*", 4th Edition, John Wiley & Sons Inc., New York, 1997.

CE 285 THERMO DYNAMICS AND FLUID MECHANICS LABORATORY

Thermodynamics:

1. Performance test on Petrol and Diesel Engines with Mechanical and Electrical Dynamometers
2. Morse test on multi-cylinder petrol engine
3. Determination of volumetric efficiency on Diesel engine and Two stage reciprocating Air compressor
4. COP in compression refrigerator cycle
5. Test on Air conditioning system
6. Viscosity index of lubricant
7. Study of steam power plant

Fluid Mechanics:

1. Determination of pipe friction
2. Calibration of flow meters – Venturimeter and Orifice meter
3. Determination of discharge coefficients for notches
4. Determination of minor losses
5. Centrifugal pump
6. Submersible pump
7. Jet pump
8. Gear pump
9. Screw pump

IC 207 CIRCUITS AND DEVICES LABORATORY

1. Verification of Circuit theorems.
2. Step response of RC and RL circuits.
3. Frequency response of a second order circuit
4. Resonance.
5. Currents and voltages in unbalanced and balanced star and delta circuits.
6. Transfer function of simple R, L, C circuits from frequency response characteristics.
7. Determination of Z, Y and h parameters of a two port network.
8. Volt-ampere characteristics of semi conductor diode and zener diodes.
9. Transistor characteristics – CE.
10. Transistor characteristics – CB.
11. Characteristics of FET.
12. Characteristics of UJT.

MA202 NUMERICAL TECHNIQUES

Solution of linear system - Gaussian elimination and Gauss-Jordan methods - LU - decomposition methods - Crout's method - Jacobi and Gauss-Seidel iterative methods - sufficient conditions for convergence - Power method to find the dominant eigenvalue and eigenvector.

Solution of nonlinear equation - Bisection method - Secant method - Regula falsi method - Newton-Raphson method for $f(x) = 0$ and for $f(x,y) = 0$, $g(x,y) = 0$ - Order of convergence - Horner's method - Graeffe's method - Bairstow's method.

Newton's forward, backward and divided difference interpolation – Lagrange's interpolation – Numerical Differentiation and Integration – Trapezoidal rule – Simpson's 1/3 and 3/8 rules - Curve fitting - Method of least squares and group averages.

Numerical Solution of Ordinary Differential Equations- Euler's method - Euler's modified method - Taylor's method and Runge-Kutta method for simultaneous equations and 2^{nd} order equations - Multistep methods - Milne's and Adams' methods.

Numerical solution of Laplace equation and Poisson equation by Liebmann's method - solution of one dimensional heat flow equation - Bender - Schmidt recurrence relation - Crank - Nicolson method - Solution of one dimensional wave equation.

References.

1. *GERALD, C.F., and WHEATLEY, P.O., Applied Numerical Analysis, Addison Wesley.*
2. *JAIN, M.K., IYENGAR, S.R. and JAIN, R.K., Numerical Methods for Scientific and Engineering Computation, Wiley Eastern.*
3. *KANDASAMY, P., THILAGAVATHY, K., and GUNAVATHY, S., Numerical Methods, Chand and Company.*

IC 202 SIGNALS AND SYSTEMS

Introduction to signals and systems: Introduction to signals, classification of signals, basic continuous- time and discrete- time signals, step and impulse functions, transformation of independent variable. Introduction to systems, properties of systems, classification of systems, mathematical model for systems, normal form of system equations, initial conditions.

Impulse response of a physical system, introduction to convolution, system impulse response and convolution integral, numerical convolution. Sampling theorem, Z-transform, convergence of Z-transform, properties of Z-transform, inversion of Z-transform , evaluation of system frequency response, applications of Z-transform.

Representation of signals in terms of elementary signals, condition for orthogonality, representation of signals by elementary sinusoids, Fourier series representation, power spectrum, Fourier Transform, system function, energy spectrum. Calculation of simple transforms, Discrete Fourier Transform (DFT), properties of Discrete Fourier Transform.

Statistical Signal Analysis: Classification of random signals, auto correlation function, properties of auto correlation function, measurement of auto correlation function, application of autocorrelation functions, cross correlation functions, properties of cross correlation functions, sum of random processes**.**

Spectral density, relation of spectral density to autocorrelation function. Auto correlation function of system output, cross- correlation between input and output, white noise, generation of pseudo-random binary noise, analysis of linear systems in time domain using white noise, mean and mean square value of system output, analysis in the frequency domain.

Text Books:

1. Gabel R.A. and Robert R.A, "*Signals and Linear Systems*", 3rd Edition, John Wiley and Sons, New York, 1987.
2. Oppenheim, Wilsky and Nawab, "*Signals and Systems*", 2nd Edition, Prentice Hall, New Delhi, 1997.
3. C.T.Chen, "*Systems and Signal Analysis*", Saunder's college pub., 2nd Edition, 1994.

Reference Books:

1. Cooper G.R and McGillem C.D, "*Probabilistic Methods of Signals and System Analysis*", 3rd Edition, Oxford University Press, Cambridge, 1999.
2. C.J Chesmond, "*Control System Technology*", Edward Arnold, London, 1988.
3. Ziemer R.E., Tranter W.H., and Fannin D.R., "*Signals and Systems*", 4th Edition, Pearson Education Asia, Singapore, 1998.

IC 204 INDUSTRIAL INSTRUMENTATION

Filled system thermometers, thermocouples – types, construction, conditioning and compensation, RTD – types, construction, measuring circuits, Thermistors. Radiation pyrometers, IC temperature sensors.

Introduction, differential pressure type flowmeters, variable area flowmeters, positive displacement flowmeters for liquids and gas services, Hot wire Anemometers, EM flowmeter and turbine flowmeter.

Ultrasonic flowmeter, Vortex flowmeter, Cross correlation flowmeter, Mass flowmeter: Direct and Indirect methods.

Pressure measurement: Introduction, Mechanical, Electromechanical and Electrical methods of measurement. Low pressure measurement.

Level measurement: Introduction, mechanical, electromechanical and electrical type. Viscocity and density measurement.

Text Books:

1. Doebelin E.O, "*Measurement Systems: Application and Design*", 4th Edition, McGraw Hill, New York, 1992.
2. Patranabis D, "*Principles of Industrial Instrumentation*", 2nd Edition, Tata McGraw Hill, New Delhi, 1997.

Reference Books:

1. Noltingk B.E., "*Instrumentation Reference Book*", 2nd Edition, Butterworth Heinemann, Oxford, 1996.
2. Liptak B.G, "*Process Measurement and Analysis*", 3rd Edition, Chilton Book Company, Radnor, Pennsylvania, 1995.
3. Douglas M. Considine, "*Process / Industrial Instruments & Controls Handbook*", 4th Edition, McGraw Hill, Singapore, 1993.

IC 206 ANALOG ELECTRONIC CIRCUITS

Diode and Amplifier circuits: Rectifier circuits. Filter circuits. Limiting and clamping circuits. Special Diode tyes. Zener voltage regulator. MOSFET and BJT circuits at DC. MOSFET and BJT as an amplifier. Biasing MOS and BJT amplifiers. Small signal operation and models for MOSFET and BJT. Single stage MOS amplifiers and BJT amplifiers. High frequency model for MOSFET and BJT.

Single stage integrated circuit amplifiers: Comparison of MOSFET and BJT. BICMOS circuits. IC biasing. High frequency response. CS and CE amplifier with active loads. High frequency response of CS and CE amplifier. CG and CB amplifiers with active loads. Cascode amplifier. CS and CE amplifiers with source de-generation. Source and emitter follower.

Differential and multi stage amplifiers: MOS differential pair and its small operation. BJT differential pair. Non ideal characteristics of differential amplifier. Differential amplifier with active load. Two stage amplifiers using MOS and two stage amplifiers using BJT.

Feedback amplifiers, Sinusoidal oscillators: General feedback structure. Properties of negative feedback. Four basic feedback topologies. Loop gain. Stability problem. Basic principle of sinusoidal oscillators. RC oscillator. LC and crystal oscillator.

Output stages and power amplifiers: Class A, class B, class AB output stages. Biasing class AB circuits. Power BJTs, MOS power transistor. Variations on the class AB configuration. IC power amplifiers. Class AB operation.

Text Books:

1. J. Millman and A. Grabel, "*Microelectronics*", 2nd Edition, McGraw Hill, 1987.
2. David A.Bell, "*Solid State Pulse Circuits*", PHI, 4th Edition, 1992.
3. A.S.Sedra and K.C.Smith, "*Microelectronics circuits*", 5th Edition, Oxford, 2004.

Reference Books:

1. D.L.Schilling and C. Belove, "*Electronic Circuits*", McGraw Hill, 3rd Edition, 1989.
2. R.Spencer and Mohammed S.Ghausi, "*Introduction to Electronic Circuit Design*", Pearson, 2003.
3. Robert L. Boylestad, "*Electronic Devices and Circuit Theory*", 8th Edition, Pearson, 2002.

IC 208 DIGITAL TECHNIQUES

Number systems & Boolean algebra: Number systems and data representation, Binary, Octal, Hexadecimal representations and their conversions, Signed numbers and floating point number representation. Codes, Basic logic operations, Boolean algebra, De-Morgan theorems, Algebraic reductions, NAND and NOR based logic, Digital logic gates.

Combinational Logic and circuits: Canonical logic forms, Extracting canonical forms, Karnaugh maps and Tabular methods, Don't care conditions, minimisation of multiple output functions.
Synthesis of combinational functions: Arithmetic circuits-Adder, carry look-ahead adder, number complements subtraction using adders, signed number addition and subtraction, BCD adders. IC adders. Multiplexers, implementation of combinational functions using multiplexers, de-multiplexers, decoders, code converters, Combinational logic with MSI and LSI. Programmable logic devices.

Sequential Logic: Flip-Flops: Basic latch circuit. Debouncing of a switch, flip-flop truth table and excitation table, integrated circuit flip-flops. Race in sequential circuits, Analysis of clocked sequential circuits, State reduction & assignment. Registers, Counters - Synchronous, Asynchronous, Up-Down, Design of counters, Design with state equations.

Digital Hardware: Logic levels, Digital integrated circuits, Logic delay times, Fan-Out and Fan-In, Logic families, Interfacing between different families.

CMOS Electronics: CMOS electronics & Electronic logic gates, The CMOS inverter, Logic formation using MOSFETs, CMOS memories. Design and analysis procedures, Logic arrays.

Text Books:

1. M.M. Mano, "*Digital Design*", 3rd Edition, Prentice Hall of India.
2. Floyd, "*Digital Fundamentals*", 4th Edition, Universal Book Stall, New Delhi, 1992.
3. J.P. Uyemura, "*A First Course in Digital Systems Design*", Brooks/Cole Publishing Co. (Available from Vikas Publishing House in India).

Reference Books:

1. J.M. Rabaey, "*Digital Integrated Circuits: A Design Perspective*", 2nd Edition, Prentice Hall of India, 2002.
2. D. Hodges and H. Jackson, "*Analysis and Design of Digital Integrated Circuits*", 2nd Edition, McGraw Hill, 1988.
3. N.H.E. Weste, and K. Eshraghian, "*Principles of CMOS VLSI Design: A Systems Perspective*", 2nd Edition, Pearson Education Inc., (Asia), 2002.

IC 210 DATA STRUCTURES & ALGORITHMS

Development of algorithm, notation analysis. Sorting and searching algorithms and their implementation under C/C++.

Stacks, queues, linked lists and their implementation under C/C++

Binary tree, B-trees. Tree traversal operations. Implementation under C/C++. Graphs, minimum cost spanning tree construction. Implementation under C/C++.

Formal definition of an algorithm in terms of turing machines.

Introduction to the class P and NP.

Text Books:

1. Tremblay and Sorenson, "*An Introduction to Data Structures with Applications*", 2nd Edition, Tata McGraw Hill, New Delhi, 1997.
2. Cormen, Leiserson, and Rivest, "*Introduction to Algorithms*", 2nd Edition, Mc Graw Hill, New York, New Delhi, 1990.
3. Horowitz, Sahni, and Rajasekaran, "*Fundamentals of Algorithms*", Galgotia Publications, New Delhi, 1999.

Reference Books:

1. Ronald L. Rivest, "*Algorithms, Data structures and Programs*", Prentice Hall, New Jersey, 1990.
2. Knuth D. E, "*Fundamental algorithms*", 3rd Edition, Addition Wesely publication, New Delhi, 1997.
3. Mark Nelson , "*STL*", Golgotia Publications, New Delhi, 1995.

IC 212 SENSORS AND TRANSDUCERS LABORATORY

1. Measurement of strain using strain gauges
2. Measurement of torque using strain gauges
3. Measurement of speed using Electro magnetic transducer
4. Measurement of speed using photoelectric transducers
5. Measurement of speed using stroboscope
6. Measurement of sound level
7. Measurement of natural frequency using Accelerometer
8. Measurement using proximity sensors
9. Measurement of angular displacement using Potentiometer
10. Design of opto coupler using photoelectric transducers
11. Measurement of displacement using LVDT
12. Measurement using load cells
13. Characteristics of Hall effect sensor
14. Measurement using capacitive transducer
15. Measurement using inductive transducer
16. Measurement of pressure using strain gauges.

IC 214 ELECTRONIC CIRCUITS LABORATORY

1. Clipping and Clamping circuits.
2. Half wave and Full wave rectifiers.
1. Bridge Rectifiers.
4. Single-stage Amplifiers
5. Multistage Amplifiers
6. Feedback Topologies
7. Frequency Response of Amplifiers
8. PSPICE Simulations

IC 301 ELECTRICAL AND ELECTRONIC MEASUREMENTS

Electro mechanical instruments: Moving coil, moving iron, dynamometer type, rectifier type, thermal instruments. Application of PMMC meter. Current transformer and potential transformer.

Power and Energy Measurements: Electrodynamic wattmeters, Hall effect wattmeter, thermal type wattmeter, compensated wattmeter, single and three phase power measurement, calibration of wattmeter. Energy measurement, maximum demand meter, P.F meter, Megger.

D.C bridges: Low, high and precise resistance measurement. A.C bridges: Inductance and capacitance measurements. Detectors in bridge measurement, Wagner ground connections, transformer ratio bridges. Series and shunt type ohmmeter.

Electronic measurements: Analog electronic multimeter, digital multimeter, digital wattmeter/energy meter. Signal Generators. Frequency measurement, measurement of period, time and phase angle.

Waveform analysing instruments: Distortion meter, Analog and digital spectrum analyzer, additional waveform analysing instruments. Oscilloscopes: General purpose oscilloscopes, special oscilloscopes.

Text Books:

2. Golding, E.W. and Widdis, F.C., "*Electrical Measurements and Measuring Instruments*" A.H.Wheeler and Co, 5th Edition, 1993.
3. Baldwin, C.T., "*Fundamentals of electrical measurements*" – Lyall Book Depot, New Delhi, 1973.
3. David.A.Bell, "*Electronic Instrumentation and Measurements*", 2nd Edition, Prentice Hall, New Jersy, 1994.

Reference Books:

1. Cooper, W.D. and Helfric, A.D., "*Electronic Instrumentation and Measurement Techniques*" Prentice Hall of India, 1991.
2. Kalsi.H.S., "*Electronic Instrumentation*", Tata McGraw Hill, New Delhi, 1995.

EC 317 PRINCIPLES OF COMMUNICATION SYSTEMS

Amplitude modulation: AM, generation of AM waves, demodulation, DSBSC, SSB, VSB, FDM, AM receivers.

Angle modulation: Phase and Frequency modulation, Single-tone, narrow band, wide band and multi tone FM, generation and demodulation of FM, FM receivers.

Pulse Analog modulations: Sampling theorem, Time Division Multiplexing, PAM, Pulse time modulation.

Pulse Digital modulation: PCM, Measure of Information, Channel capacity, DPCM, DM, Digital multiplexers.

Noise: SNR, Noise in AM and FM receivers, Noise in FM reception, FM Threshold effect, Pre-emphasis and de-emphasis, Noise in PCM system, Destination SNR in PCM system with quantization and channel noise, output SNR in DM system.

Text Books:

1. S.Haykin, "*Communication Systems*", 4th Edition, John Wiley & Sons, 2000.
2. H.Taub & D.Schilling, "*Principles of Communication System*", 2nd Edition, McGraw Hill.

Reference Books:

1. B.Carlson, "*Communication Systems*", 3rd Edition, McGraw Hill Book Co., 1986.
2. Sam Shanmugam, "*Digital and analog Communication Systems*", John Wiley, 1985.
3. H.Stark & F.B.Tuteur, "*Modern Electrical Communication*", 2nd Edition, PHI.

IC 303 MICROPROCESSORS AND MICROCONTROLLERS

Introduction to computer architecture and organisation: Architecture of 8-bit microprocessors, bus configurations, CPU module, introduction to assembly language and machine language programming, instruction set of a typical 8-bit microprocessor, subroutines and stacks, programming exercises.

Memory technology: Timing diagrams, Memory families, memory interfacing, programmable peripheral interface chips, interfacing of input-output ports, programmable interval timer.

Data transfer schemes: Serial and parallel data transfer schemes, interrupts and interrupt service procedure. Programmable interrupt controller. Programmed and interrupt driven data transfer. Programmable DMA controller.

Architectures of 8051 Microcontroller: Bus configuration, instruction sets, programming exercises.

Microcontroller system software and hardware design, development and trouble shooting tools.

Text Books:

1. Ramesh Goankar, "*Microprocessor Architecture, Programming and applications, with the 8085/8080A*", 3rd Edition, Penram International Publishing house, 2002.
2. Kenneth J.Ayala, "*The 8051 Micro controller*", Penram Interfacing Publishing, 1996.
3. Douglas V.Hall, "*Microprocessors and Interfacing – Programming and Hardware*", 2nd Edition, Mc Graw Hill, 1992.

Reference Books:

1. B.Ram, "*Fundamentals of Microprocessors and Microcontrollers*", 4th Edition, Dhanpatrai and sons, 1994.
2. Myke Predko, "*Programming and Customizing the 8051 micro controller*", Tata-McGraw Hill, 3rd reprint 2002.

IC 305 LINEAR INTEGRATED CIRCUITS

Resistive Feedback: Introduction, The 741 Op-Amp as a circuit element, Basic Op-Amp configurations, Ideal Op-Amp circuit analysis, Negative feedback, Loop gain and sensitivity, I/V and V/I converters, Instrumentation Amplifier and applications, Transducer bridge amplifier.

Dynamic Feedback: The integrator and the differentiator circuits, Transfer function H(jω), First-order circuits and some applications, Second-order circuits, KRC filters, Multiple feedback filters, State-variable and Biquad filters, Switched-capacitor filters.

Op-Amp Limitations: The Op-Amp circuit diagram, Input bias and offset currents, Input offset voltage, Input offset error compensation, Maximum ratings, Open-loop and closed-loop response, Input and output impedances, Transient response, Effect of finite gain-bandwidth product, Current feedback amplifiers, Op-Amp noise, Low-noise Op-Amps.

Comparators & Signal Generators: Voltage comparators, Schmitt triggers, Precision rectifiers, Peak detectors, Sample-and-hold amplifiers, Multivibrators and IC 555, Waveform generators, V/F and F/V converters, Voltage references, Linear regulators, D-to-A and A-to-D converters and ICs.

Other Op-Amp Circuits: Log/Antilog amplifiers, Analog multipliers, Transconductance Amplifiers, Voltage Controlled Oscillators, Phase detectors, Phase-Locked Loops, PLL ICs, PLL applications.

Text Books:

1. S. Franco, "*Design with Operational Amplifiers and Analog Integrated Circuits*", 3rd Edition, Mc-Graw Hill Inc., 2002. (Available from Tata McGraw Hill in India).
2. Roy,D. Choudary and Shail Jain, "*Linear Integrated Circuits*", New age International, 2001.

Reference Books:

1. J. Dostal, "*Operational Amplifiers*", 2nd Edition, Butterworth-Heinemann, Stoneham, MA 1993.
2. T.M. Frederiksen, "*Intuitive Operational Amplifiers: From Basics to Useful Applications*", McGraw Hill Inc., 1988.

IC 307 PROGRAMMING TOOLS & TECHNIQUES

Introduction to scripting languages. Study of any one scripting language in depth.

Introduction to program generation using lex and yacc.

Introduction to GUI development under Windows and Linux.

Introduction to STL.

Introduction to UML tools such as umbrello, reverse engineering dissemblers and document generation tools for reverse engineering.

(The evaluation will be assignment based and testing will be based on proficiency in tool usage.)

References:

1. The documentation associated with the tools should be adequate.

IC 309 CONTROL SYSTEMS

Systems and their representation: Terminology and basic structure of control system, Open loop and Closed loop systems, servomechanism, regulatory system, analogous systems, electrical analogy of physical systems, Physical Systems and their models, transfer function, Block diagram representation of physical systems, Block diagram algebra, Signal Flow graph and Mason's formula.

Time response: Time response analysis and design: Types of test inputs, Response of first and second order system, Time domain specifications, Error coefficients, generalised error series, Response with rate, reset and PID controllers.

Root Loci: Effect of pole zero addition, desired closed loop pole location, Root locus plot, Properties of Root loci and applications, Stability range from the loci. Determination of roots of the closed loop system, transient response and stability from root locus.

Frequency response: Frequency-domain techniques - Bode and Nyquist plots, Frequency response for systems with transportation lag, Frequency-domain specifications, constant M and N circles.
Concepts of stability: Characteristic equation, location of roots in s-plane for stability, Asymptotic stability and relative stability, Routh-Hurwitz stability criterion, Nyquist stability criterion, Bode plots- gain margin and phase margin.

Control system design: Performance criteria, selection of controller modes, compensators- – lag, lead, and lag-lead networks, – compensator design for desired response.

Text Books:

1. Ogata K, "*Modern Control Engineering*", 4th Edition, Prentice Hall, New Delhi, 2002.
2. I.J.Nagarath and M.Gopal, "*Control System Engineering*", Wiley Eastern Ltd., Reprint 1995.
3. B.C Kuo, "*Automatic control systems*", 7th Edition, Prentice Hall, New Delhi, 2002.

Reference Books:

1. Chen C. T, "*Analog and Digital Control System Design*", Saunders College Publishing, Japan, 1993.
2. D'azzo and Houpis, "*Linear Control System Analysis and Design*", 4th Edition, McGraw Hill, Singapore, 1995.
3. Shinners S. M., "*Modern Control Engineering*", Prentice Hall, New Jersey, 1995

IC 311 LINEAR INTEGRATED CIRCUITS LABORATORY

1. Op-Amp circuits with resistive feedback
2. Instrumentation Amplifier
3. Op-Amp filters
4. Waveform generators
5. Schmitt trigger & Precision rectifiers
6. Multivibrators
7. PLLs
8. Combinatorial & Sequential circuits
9. Multiplexers & Demultiplexers
10. A/D and D/A converters
11. TTL and other logic gates
12. PSPICE simulations

IC 313 MICROPROCESSOR AND MICROCONTROLLERS LABORATORY

1. Familiarisation with 8085 microprocessor kit and its keyboard.
2. Exercises with entry and manipulation of data (Different addressing modes).
3. Programming exercises using 8085 microprocessor.
4. Programming exercises to programmable peripheral interface.
5. Programming exercises using interrupts.
6. Programming an EPROM for a specific application.
7. Programming exercises to programmable timer
8. Familiarisation 8051 Microcontroller kit and its assembler
9. Programming exercises using 8051 Microcontroller.
10. Mini project using closed loop control using 8085 microprocessor or 8051 Microcontroller

IC 302 MODERN CONTROL THEORY

Systems in state space: Concept of states and state model, State equation from transfer function, Modeling of dynamical systems, State space representation of multivariable systems, Building blocks of state space models. Modeling through energy approach of electrical, mechanical and electromechanical systems.

Canonical forms, Solution to state-space equations, state transition matrix, properties of state transition matrix, computation of state transition matrix.

Equilibrium points and stability concepts, stability definitions, Modeling energy of the system in terms of quadratic functions, Direct method of Lyapunov criterion for LTI systems.

Definition of controllability, observability, stabilizability and detectability. State feedback control for controllable canonical form, State feedback control in general

Output feedback control. Full-order and reduced-order observers, Use of Lyapunov's method in feedback design – Linear Quadratic problems.

Text Books:

1. Brogan W. L, "*Modern Control Theory*", 3rd Edition, Prentice Hall Inc., New Jersey, 1990.
2. Raymond A. DeCarlo, "*Linear Systems, A state variable approach with numerical implementation*", Prentice Hall Inc., New Jersey, 1987.
3. Ogata K, "*Modern Control Engineering*", 4th Edition, Prentice Hall, New Delhi, 2002.

Reference Books:

1. Skelton R. E, "*Dynamic System Control and Linear Systems Analysis and Synthesis*", John Wiley 1993.
2. Kuo B. C, "*Automatic Control Systems*", 7th Edition, Prentice Hall, New Delhi, 1995.
3. C.T. Chen, "*Linear System Theory and Design*", 3rd Edition, Oxford University Press, UK, 1998.

IC 304 PROCESS CONTROL

Process Control System: Terms and objectives, piping and instrumentation diagram, instrument terms and symbols. Regulator and servo control, classification of variables. Process characteristics: Process equation, degrees of freedom, modelling of simple systems – thermal, gas, liquid systems. Process lag, load disturbance and their effect on processes. Self-regulating processes, interacting and non-interacting processes.

Controller modes: Basic control action, two position, multiposition, floating control modes. Continuous controller modes: proportional, integral, derivative. Composite controller modes: P-I, P-D, P-I-D , integral wind-up and prevention. Auto / Manual transfer, Bumpless transfer. Electronic controllers, their implementation and design. Response of controllers for different test inputs. Selection of control modes for processes like level, pressure, temperature and flow.

Process loop tuning: Evaluation criteria - 1/4th decay ratio, IAE, ISE, ITAE. Process reaction curve method, continuous oscillation method, damped oscillation method. Auto tuning. Closed loop response of I & II order systems, with and without valve, measuring element dynamics.

Final control elements: Pneumatic control valves, construction details, types, various plug characteristics. Valve sizing. Selection of control valves. Inherent and installed valve characteristics. Cavitation and flashing in control valves. Valve actuators and positioners. Instrument air supply. Other final control elements like stepper motors and drives.

Dead-time estimation and compensation: Cascade control, ratio control, feed forward control. Over-ride, split range and selective control. Multivariable process control, interaction of control loops. Examples - Distillation column, boiler drum level control and chemical reactor control.

Text Books:

1. Stephanopoulos, "*Chemical Process Control: An introduction to Theory and Practice*", Prentice Hall, New Delhi, 1999.
2. Coughanowr, "*Process Systems Analysis and Control*", 2nd Edition, McGraw Hill, Singapore, 1991.
3. Peter Harriott, "*Process Control*", Tata McGraw Hill, New Delhi, 1985.

Reference Books:

1. Smith C.L and Corripio.A..B, "*Principles and Practice of Automatic Process Control*", 2nd Edition, John Wiley and Sons, New York, 1985.
2. Shinskey, "*Process Control Systems*", 4th Edition, McGraw Hill, Singapore, 1996.
3. Paul W.Murril, "*Fundamentals of Process Control Theory*", 3rd Edition, ISA press, New York, 2000.

IC 306 PRODUCT DESIGN AND DEVELOPMENT

Course Aim: The course is intended to provide the students with:

1. Competence in a set of tools and methods for product design and development.
2. Confidence in their own abilities to create a new product.
3. Exposure to the role of different functions in creating a new product.
4. Capability to coordinate different, interdisciplinary tasks in order to achieve the objective of creating a new product.
5. Ability to consolidate and build on specific knowledge from other courses through practice and reflection in a realistic and result – oriented setting.

Expected outcome of the course: The students are expected to have a realistic team project. The project may preferably have a specific instrumentation and / or control engineering content to it. The initial classes will be towards familiarizing the students in the various aspects of the product design and development cycle. During the practical hours of the course the students may work in the appropriate labs or work-shops. The students are expected to work as a team. At the end of the course the students are required to come out with a working and marketable model of the produc**t.**

Evaluation of the course: The students will be evaluated on their specific knowledge of industrial design, engineering, p**ro**duction and economics during the cycle tests. The final evaluation will be done only after the final working model is completed. In case the students did not complete the prototype during the semester period, they will have to complete it during the summer vacation to earn the credits. To pass this course, the team must submit at least the alpha prototype of the product.

Project material and expenses: The students are required to choose a reasonably inexpensive project. The material and facilities provided by the Institute will be restricted to what is available in the Institute at that time. The overall team budget is Rs. 2000/- for a team of five students. Any expenditure beyond this amount must be borne by the team. If the team has any intention of developing a product with a aim of marketing it, they may do so. But the expenses should be born by the team beyond the stipulated limit.

Intellectual property rights: The teams will generally retain the Intellectual Property Rights of the inventions they develop during the course. They may even patent it themselves.

CLASS SCHEDULE

Class – 1 Introduction	Class – 2 Product Planning
Class – 3 Identifying Customer Needs	Class – 4 Project Selection *Project Proposal must be submitted*
Class – 5 Product Specification	Class – 6 Concept Generation *Mission statement and customer needs must be submitted*
Class – 7 Industrial Design	Class – 8 Concept Selection *Concepts sketched and target specification must be done*
Class – 9 Prototyping	Class – 10 Product Architecture

	Preliminary concept selection must be done
Class – 11 Lecture by a Project Consultant	Class – 12 Peer Concept Review
Class – 13 Product Development Economics	Class – 14 Design for Manufacturing
Class – 15 Robust Design *Drawings, plans and revised schedule must be submitted*	Class – 16 Lecture by a Project Consultant
Class – 17 Intellectual Property	Class – 18 Concept Testing *Financial model and patent review must be submitted.*
Class – 19 Case Study	Class – 20 Design for Environment
Class – 21 Organizing Concurrent Engineering	Class – 22 Supply Chain Design
After one week: *Alpha prototype must be submitted*	After one week : *The report on alpha prototype testing and evaluation and the beta prototype must be submitted.*
After one week: *The report on beta prototype testing and customer evaluation must be submitted along with final market ready model.*	After three days : Final Presentation. *Demonstration of the working model.*

Text Books:

1. Karl T. Ulrich and Steven D. Eppinger, "*Product Design and Development*", 3rd Edition, Tata McGraw- Hill, 2003, Price Rs. 250/-, ISBN 0-07-058513-X
2. Kevin Otto and Kristin Wood, "*Product Design*", Pearson Education, 2003, ISBN : 8129702711, Price Rs. 450 /-

Web Resources:

1. www.ocw.mit.edu
2. www.uspto.gov
3. www.businessweek.com
4. www.epa.gov
5. www.hbsp.harvard.edu
6. www.patent.gov.uk

IC 308 PERSONAL COMPUTERS AND INTERFACING

Review of microprocessors: Advanced microprocessor architectures. Introduction to Intel and Motorola families. Introduction to the Power PC processors.

Overview of the PC architecture: Introduction to synchronous and asynchronous buses. Overview of various PC buses: Evaluation, PCI bus and its features. Introduction to Plug and Play architecture.

Fundamental concepts of operating systems: Introduction to operating systems. Input/output, processes, inter process communication and synchronization, memory management, file management, ROM-BIOS services. Case study of various personal computer based operating systems. Relevance of the above operating systems to process control applications.

Hardware Interfacing: Peripheral devices, graphics device interface, introduction to device drivers. Anatomy of a device driver under atleast two operating systems.

Recent trends in interfaces: Introduction to the Universal Serial Bus (USB). Overview of standards (such as IEEE1394, etc.)

Text Books:

1. Charles Crowley, "*Operating Systems*", Tata McGraw Hill, New Delhi, 1998.
2. Hans-Peter Messmer, "*The Indispensable Pentium Book*", Addison Wesley Publishing Company, Singapore, 1995.
3. Daniel A. Norton, "*Writing WINDOWS Device Drivers*", Addison Wesley Publishing Company, Singapore, 1992.

Reference Books:

1. Tom Shanley, "*PCI System Architecture*", 4th Edition, Addison Wesley Mindshare Series, Singapore, 1997.
2. Tom Shanley, "*Plug and Play Architecture*", Addison Wesley Mindshare Series, Singapore, 1997.
3. Don Anderson, "*PCMCIA System Architecture*", Addison Wesley Mindshare Series, Singapore, 1997.

IC 310 COMPUTER NETWORKS

Computer communication architecture: Network topology, Switching: Circuit switching and packet switching, datagrams and virtual circuits, ISO reference model for layered architecture, functions of various layers.

Local area networks: Objectives and advantages of PC LANs, topologies for LANs, media for LANs, medium access control techniques: CSMA, CSMA/CD, Token bus and token ring, performance analysis for LANs.

Internetworking: Basic principles, bridges and routers, connection oriented and connectionless internetworking. Introduction to the protocols in the TCP/IP protocol suite.

ISDN and B – ISDN, frame relay and asynchronous transfer mode. Data compression. Data security and authentication techniques.

Network management, electronic mail, network security, other internet applications. Test techniques for data networks: Basic tests, transmission impairment measurement tests, Time Domain Reflectometry (TDR). Line monitors and protocol analyzers.

Text Books:

1. Stalling W, "*Data and Computer Communications*", 5th Edition, Prentice Hall, New Delhi, 1997.
2. William Stallings, "*High-speed Networks-TCP/IP and ATM Design Principles*", Prentice Hall, New Jersey, 1998.
3. Richard H. Baker, "*Network Security - How to plan for it and achieve it*", McGraw Hill Inc., New York, 1995.

Reference Books:

1. Ed Taylor, McGraw -Hill "*Internetworking Handbook*", 2nd Edition, McGraw Hill, New York, 1998.
2. Bertsekas D and Gallager. R, "*Data Networks*", 2nd Edition, Prentice Hall, New Delhi, 1992.
3. Viswanathan T, "*Telecommunication Switching Systems and Networks*", Prentice Hall, New Delhi, 1992.

IC 312 PERSONAL COMPUTERS & INTERFACING LABORATORY

1. Data acquisition using PC-add on cards under different operating systems.
2. Data transfer via Modem under various operating systems.
3. Installation of device drivers under various operating systems. e.g. mouse, CD-ROM, scanner, process controller.
1. Setting up a PC based LAN network, System integration with various operating systems.
2. Development of simple database applications.
3. Development of a virtual instrument using GUI and Sub VIs.
4. Measurement and logging of a process data and generating a report.
5. Measurement of vibration of a given structure and analyzing the data.
6. Measurement of strain of a given structure and publishing it in the web.
7. Control of temperature using Multifunction RT Data Acquisition card
8. Control of a given process using Real Time Embedded controller
9. Control of temperature using Distributed input/output modules.

IC 314 CONTROL ENGINEERING LABORATORY

1. Frequency response characteristics of a second order system.
2. Time response characteristics of a second order system.
3. Constant gain compensation in time and frequency domain.
4. Compensating Networks – Characteristics
5. Design of compensation networks
6. Design of state feedback.
7. Observer design.
8. Study of PD, PI, PID controller (Electronic Version and Process Simulator)
9. Microprocessor based servo system.
10. Speed Control system (Open loop & closed loop).
11. Real time control of Inverted Pendulum.
12. Real time control of Gyroscope.

IC 401 LOGIC AND DISTRIBUTED CONTROL SYSTEMS

Review of computers in process control: Data loggers, Data Acquisition Systems (DAS), Direct Digital Control (DDC). Supervisory Control And Data Acquisition Systems (SCADA), sampling considerations. Functional block diagram of computer control systems. Characteristics of digital data, controller software, linearization. Digital controller modes: Error, proportional, derivative and composite controller modes.

Programmable logic controller (PLC) basics: Definition, overview of PLC systems, input/output modules, power supplies and isolators. General PLC programming procedures, programming on-off inputs/ outputs. Auxiliary commands and functions, PLC Basic Functions, register basics, timer functions, counter functions.

PLC intermediate functions: Arithmetic functions, number comparison functions, Skip and MCR functions, data move systems. PLC Advanced intermediate functions: Utilising digital bits, sequencer functions, matrix functions. PLC Advanced functions: Alternate programming languages, analog PLC operation, networking of PLC, PLC-PID functions, PLC installation, troubleshooting and maintenance. Design of interlocks and alarms using PLC, creating ladder diagrams from process control descriptions.

Distributed Control Systems (DCS): Definition, Local Control Unit (LCU) architecture, LCU languages, LCU - Process interfacing issues, communication facilities, configuration of DCS, displays, redundancy concept - case studies in DCS.

Field bus: Introduction, concept. Communication protocols. Smart transmitters and smart actuators.

Text Books:

1. John.W. Webb Ronald A Reis, "*Programmable Logic Controllers - Principles and Applications*", 4th Edition, Prentice Hall Inc., New Jersey, 1998.
2. Lukcas M.P, "*Distributed Control Systems*", Van Nostrand Reinhold Co., New York, 1986.
3. Frank D. Petruzella, "*Programmable Logic Controllers*", 2nd Edition, McGraw Hill, New York, 1997.

Reference Books:

1. Deshpande P.B and Ash R.H, "*Elements of Process Control Applications*", ISA Press, New York, 1995.
2. Curtis D. Johnson, "*Process Control Instrumentation Technology*", 7th Edition, Prentice Hall, New Delhi, 2002
3. Krishna Kant, "*Computer-based Industrial Control*", Prentice Hall, New Delhi, 1997.

IC 403 ANALYTICAL INSTRUMENTATION

Electromagnetic radiation and its interaction with matter: Spectral methods of analysis, absorption spectroscopy, Beer's law, radiation sources, monochromators, flitters, prisms, diffraction grating, ultraviolet spectrometer, single beam and double beam instruments, detectors, choice of solvent.

Infrared spectrophotometer: Sources, cells, detectors, sample preparation, analysis using Attenuated Total Reflectance (ATR). Atomic absorption spectrometry: Wavelength choice, sources, cells and detectors. Flame emission spectrometry. Atomic fluorescence spectrometry. Applications of spectroscopy techniques.

Radioactive measurement: Measurement of radioactivity, application of radio nuclides in analysis. X-ray spectroscopy: X-ray absorption methods, X-ray fluorescence methods, X-ray diffraction. Nuclear Magnetic Resonance (NMR) spectroscopy: Basic principles, continuous wave NMR spectrometer, pulsed Fourier transform NMR spectrometer, and its applications.

Sampling: Sample collection for gas, liquid and solid analysis, pH measurement: Basic principles, ion selective electrodes, glass and reference electrodes, measuring circuit. Electrical conductivity measurement: Measuring circuit, water and steam purity measurement. Oxygen measurement: Paramagnetic oxygen analysers, ceramic electrode for high temperature oxygen measurement and dissolved oxygen measurement.

Flue gas analysis: Measurement techniques for CO, carbon dioxide, NOX and SOX. Dust and smoke measurement, moisture measurement in solids, liquids and gases. Chromatography: Basic principles of gas and liquid chromatography, column details. Detectors: Thermal conductivity detector, flame ionisation detector, flame photometric detector, electron capture detector. Effect of temperature. High pressure liquid chromatography: Basic principles, precolumn, separation column, detectors.

Text Books:

1. Willard, Merritt, Dean and Settle, "*Instrumental Methods of Analysis*", 7th Edition, CBS Publishers and Distributors, India, 1988.
2. Ewing G.W, "*Instrumental Methods of Analysis*", 5th Edition, McGraw Hill, Singapore, 1992.
3. Jain R. K, "*Mechanical and Industrial Measurements*", Khanna Publishers, Nai Sarak, Delhi, 1985.

Reference Books:

1. Considine D.M, "*Process / Industrial Instruments and Controls Handbook*", 4th Edition, McGraw Hill, Singapore, 1993.
2. Liptak B.G, "*Process Measurement and Analysis*", 3rd Edition, Chilton Book Company, Pennsylvania, 1995.
3. Sherman R.E. and Rhodes L.J. (Eds), "*Analytical Instrumentation*", ISA Press, New York, 1996.

HM 401 INDUSTRIAL ECONOMICS

Demand and Supply – Forecasting techniques – Cost and Revenues – competitive nature of the firms – Keynesian economics – National income – Trade cycle – Inflation – Index numbers – Capital budgeting – Cash flow analysis – Balance sheet – Risk and Decision Making – Technical Change in Global Economy – Locating the Firm in a global Economy – Taxes and Decision Making – Exchange Rate determination – Marketing – Product life cycle – Marketing research – Branding – Personality – Motivation – Leadership – Working in Teams.

Reference Books:

1. Manb Adhikari, "*Business Economics*", Excel Books, 2004.
2. Misra.S.K. and Puri.V.K., "*Economics Environment of Business*", HP,2003.

IC 405 BIOMEDICAL INSTRUMENTATION

Electro physiology: Review of physiology and anatomy, resting potential, action potential, bioelectric potentials, cardiovascular dynamics, electrode theory, bipolar and uni-polar electrodes, surface electrodes, physiological transducers. Systems approach to biological systems.

Bioelectric potential and cardiovascular measurements: EMG - Evoked potential response, EEG, foetal monitor. ECG phonocardiography, vector cardiograph, BP, blood flow cardiac output, plethysmography, impedance cardiology, cardiac arrhythmia's, pace makers, defibrillators.

Respirator and pulmonary measurements and rehabilitation: Physiology of respiratory system, respiratory rate measurement, artificial respirator, oximeter, hearing aids, functional neuromuscular simulation, physiotheraphy, diathermy, nerve stimulator, artificial kidney machine.

Patient monitoring systems: Intensive cardiac care, bedside and central monitoring systems, patient monitoring through bio-telemetry, implanted transmitters, telemetering multiple information. Sources of electrical hazards and safety techniques.

Recent trends: Medical imaging, X-rays, laser applications, ultrasound scanner, echo cardiography, CT Scan MRI/NMR, cine angiogram, colour doppler systems, Holter monitoring, endoscopy.

Text Books:

1. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, "*Biomedical Instrumentation and Measurements*", 2nd Edition, Prentice Hall, New Delhi, 1998.

Reference Books:

1. Geddes L. A. and Baker L. E., "*Principles of Applied Biomedical Instrumentation*", 3rd Edition, John Wiley, New York, 1989.
2. Richard Aston, "*Principles of Bio-medical Instrumentation and Measurement*", Merril Publishing Company, New York, 1990.
3. Kandpur R. S, "*Handbook of Biomedical Instrumentation*", Tata McGraw Hill, New Delhi, 1987.

IC 407 INSTRUMENTATION LABORATORY

1. Design of temperature transmitter using RTD.
2. Design of cold junction compensation circuit.
3. Design of IC temperature transmitter.
4. Design of Linearization circuit for thermistor.
5. Design of pressure transmitter.
6. Performance evaluation of pressure gauges using Dead weight tester.
7. Measurement of level using capacitance probe, differential pressure transmitter.
8. Design of alarms and annunciators.
9. Measurement of pH, conductivity and turbidity.
10. PC based respiratory analyser.
11. PC based ECG, pulse analyser.
12. Audio tone analyser.
13. Blood pressure calibrator.
14. Characteristics of I/P and P/I.
15. Measurement of flow using orifice, electro magnetic and positive displacement flowmeters.

IC 409 PROCESS CONTROL LABORATORY

1. Experimental study of PID controller response on a level loop.
2. Experimental study of ON-OFF and Proportional controller responses on temperature loop.
3. Tuning of controllers on a pressure loop.
4. Control valve characteristics with and without positioner.
5. Modeling of flow process.
6. Study of complex control systems (Ratio, Feedforward, and Cascade).
7. Study of Distillation column.
8. Study of basic logic operations, timer, counter, arithmetic operations in PLC.
9. Study of analog operations in PLC.
10. Problem solving in PLC.

The following experiments will be conducted on virtual DCS.

11. Three – element boiler control
12. Binary distillation column control
13. Level control in coupled tanks
14. Pressure control in different sized vessels
15. Heat exchanger control
16. Control of rotary dryer

IC 402 OPTO-ELECTRONICS AND LASER BASED INSTRUMENTATION

Introduction: Characteristics of optical radiation, electro - luminescence. Light emitting diode, heterojunction diode, internal and external photo effects.

Optical Sources: Photo diode, PIN diode, schottky, barrier diode, heterojunction diode, APD, photo-transistor, photo-thyristor, photo- thermistor.

Charge couples devices: Opto-couplers and their application in analogue and digital devices. Optical fibre fundamentals, modes, types of optical fibres, fibre coupling.

Characteristics of LASERS: Laser rate equation, properties, modes, two, three and four level system, Resonator configuration, Q switching and mode locking, cavity dumping, simple frequency operation. Types of Lasers.

Industrial applications of LASERS: Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, sonic boom, pollutants, current and voltage. Material processing: Laser heating, melting, scribing, splicing, welding and trimming of materials, removal and vaporisation, calculation of power requirements.

Text Books:

1. Wilson and Hawkes, "*Opto Electronics - An Introduction*", 3rd Edition, Prentice Hall, New Delhi, 1998.
2. Bhattacharya P, "*Semiconductor Optoelectronics*", 2nd Edition, Prentice Hall, New Delhi, 1998.
3. Djafar.K.Mynbaev, Lowell.L.Scheiner, "*Fiber-Optic Communications Technology*", 2nd Indian Reprint, Pearson Education Pte. Ltd., 2001.

Reference Books:

1. Culshaw B. and Dakin J.(Eds.), "*Optical Fibre Sensors Vol I, II and III*", Artech House, 1989.
2. Fukuda, "*Optical Semiconductor Devices*", Allied Publishers Limited, Chennai, 1999.
3. Kasap, "*Optoelectronics and Photonics: Principles and practices*", Allied Publishers Limited, Chennai, 2001.

MB 790 MANAGEMENT CONCEPTS AND PRACTICES

Introduction to management, evolution of scientific management, modern management, principles. Element of management. Planning, Organizing, Staffing, Directing, Co-ordinating, Reporting, Budgeting. Core concepts of marketing, Need, want, demand, product, value, satisfaction, marketing mix – product, price, place, promotion. Financial management, Objectives, Scope, Techniques of investment analysis, Pay back period, Accounting Rate of Return, Working capital. Sources of financing. Technology management, product design, Types of production system. Plant location – Factors to be considered. Plant layout. Types of layout, Inventory management. Project Management – PERT – CPM – Applications. Significance of HRM, HR Planning – Job evaluation – Recruitment & selection – Placement and induction – Training – Performance appraisal – Compensation – Industrial relations.

Reference Books:

1. L.M.Prasad, "*Principles & Practice of Management*", Sultan Chand & Sons, New Delhi.
2. Philip Kotler, "*Marketing Management*", 12th Edition, Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2005.
3. Prasanna Chandra, "*Financial Management Theory and Practise*", 3rd Edition, Tata McGraw Hill, 2004.

ELECTIVES

IC 352 POWER ELECTRONICS

Power semiconductor switches: Power diodes, Power transistors, Triac-GTOs-power MOSFETs, IGBTs, MCTs, SCRs - series and parallel connections, driver circuits, turn-on characteristics, turn off characteristics.

AC to DC converters: Natural commutation, single phase and three phase bridge rectifiers, semi controlled and fully controlled rectifiers, dual converters, inverter operation.

DC to DC converters: Voltage, Current, load commutation, thyristor choppers, design of commutation elements, MOSFET/IGBT choppers, AC choppers.

DC to AC converters: Thyristor inverters, McMurray-Mc Murray Bedford inverter, current source inverter, voltage control, inverters using devices other than thyristors, vector control of induction motors.

AC to AC converters: Single phase and three phase AC voltage controllers, integral cycle control, single phase cyclo-converters - effect of harmonics and Electro Magnetic Interference (EMI).

Text Books:

1. Rashid M. H, "*Power Electronics - Circuits, Devices and Applications*", 2nd Edition, Prentice Hall, New Delhi, 1995.
2. Dubey G. K, Doradla S.R, Joshi and Sinha R.M, "*Thyristorised Power Controllers*", New Age International Publishers, New Delhi, 1996.

Reference Books:

1. Vedam Subramanyam K, "*Power Electronics*", 2nd Edition, New Age International Publishers, New Delhi, 1997.
2. Mohan, Undeland and Robbins, "*Power Electronics*", John Wiley and Sons, New York, 1995.
3. Joseph Vithyathil, "*Power Electronics*", McGraw Hill, New York, 1995.

IC 354 MICRO ELECTRO MECHANICAL SYSTEMS

Introduction, emergence, devices and application: market, challenges and technology trend and scaling issues.

Materials for MEMS, Surface and Bulk micromachining.

Microsterolithography, LIGA process.

Devices and applications. Electronic interfaces.

Design, Simulation & Layout of MEMS devices using CAD tools.

Books:

1. Tai Ran Hsu, "*MEMS & Microsystem Design and Manufacture*", Tata McGraw Hill, New Delhi 2002.
2. Marc Madou, "*Fundamentals of Micro fabrication*", CRC Press, 1999.
3. Julian W. Gardner and Vijay K. Varadan, "*Microsensors, MEMS, and Smart Devices*", John Wiley & Sons Ltd, 2001.

IC 451 EMBEDDED SYSTEMS AND RTOS

Embedded Software - Real time and Non Real time - Introduction to Real-time Systems and Embedded Real-time Systems - Linking - Compiling – Locators - Development Tools - operating system structures– Scheduling Algorithms - Inter task communication and Synchronization – Inter-process Communication – Signals

RTOS kernel – real time programming – RTOS multitasking – RT Scheduling – Co-operative /Non cooperative processing – Synchronization – Inter task communication and Event group - RTOS kernel System calls

RTOS porting to a target – comparison and study of various RTOS like VxWorks – pSOS – C Executive - Emulator – Simulator - Debugging techniques.

TCP/IP suite – Encapsulation - IP datagrams, fragmentation and reassembling – IP addresses – Subnetworks - ARP - RARP - ICMP - TCP/UDP datagrams - Port Number and associations – socket types - Binding local names - Connection oriented - Connection less socket.

Case Studies, examples of complete embedded systems using mc68 HC11, mc8051, PIC series of microcontroller - IEEE1451.1 and IEEE1451.2 plug and play standard – RTOS for Image processing – Embedded RTOS for voice over IP – RTOS for fault tolerant applications – RTOS for control systems.

Reference Books:

1. Jean J. Labrosse, "*Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C*", CMP Books, Independent bookstore online since 1999.
2. Herma K, "Real Time Systems – Design for distributed Embedded Applications", Kluwer Academic, 1997.
3. Daniel W. Lewis, "*Fundamentals of Embedded Software where C and Assembly meet*", PHI, 2002.

IC 453 VIRTUAL INSTRUMENTATION

Virtual Instrumentation: Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

VI programming techniques: VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

Data acquisition basics: Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

VI Chassis requirements. Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

VI toolsets, Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control.

Text Books:

1. Gary Johnson, "*LabVIEW Graphical Programming*", 2nd Edition, McGraw Hill, New York, 1997.
2. Lisa K. wells & Jeffrey Travis, "*LabVIEW for everyone*", Prentice Hall, New Jersey, 1997.

Reference Books:

1. Kevin James, "*PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control*", Newnes, 2000.

Web Resources:

1. www.ni.com
2. www.ltrpub.com

IC 452 POWER PLANT INSTRUMENTATION AND CONTROL

Brief survey of methods of power generation-hydro, thermal, nuclear, solar and wind power – Introduction to thermal power plant processes – building blocks - ideal steam cycles – Boiler – types, Boiler - turbine units and its range systems, feed water systems, steam circuits, combustion process, products of combustion process, fuel systems, treatment of flue gases, steam turbine, condensate systems, alternator, feed water conditioning, turbine bypass valves. Importance of instrumentation in power generation – details of boiler processes, P & I diagram of boiler – combined cycle power plant, power generation and distribution.

Measurement in boiler and turbine: Metal temperature measurement in boilers, piping system for pressure measuring devices, smoke and dust monitor, flame monitoring. Introduction to turbine supervising system, pedestal vibration, shaft vibration, eccentricity measurement. Installation of non-contracting transducers for speed measurement, rotor and casing movement and expansion measurement.

Controls in boiler: Problems associated with control of multiple pulverizers. Draught plant: Introduction, natural draught, forced draught, induced draught, power requirements for draught systems. Fan drives and control, control of air flow. Combustion control: Fuel/Air ratio, oxygen, CO and CO_2 trimming, combustion efficiency, excess air, parallel and cross limited combustion control, control of large systems.

Controls in boiler: Boiler drum level measurement methods, feedwater control, soot-blowing operation, steam temperature control, Coordinated control, boiler following mode operation, turbine following mode operation, sliding pressure mode operation, selection between boiler and turbine following modes. Distributed control system in power plants-interlocks in boiler operation. Turbine control: Shell temperature control-steam pressure control – lubricant oil temperature control – cooling system.

Nuclear power plant instrumentation: Piping and instrumentation diagram of different types of nuclear power plant, Nuclear reactor control loops, reactor dynamics, excess reactivity, pulse channel and logarithmic instrumentation, control and safety instrumentation, reliability aspects.

Text Books:

1. Sam. G.Dukelow, "*The Control of Boilers*", 2nd Edition, ISA Press, New York, 1991
2. Gill A..B, "*Power Plant Performance*", Butterworth, London, 1984.
3. P.C Martin, I.W Hannah, "*Modern Power Station Practice*", British Electricity International Vol. 1 & VI, Pergamon Press, London, 1992.

Reference Books:

1. David Lindsley, "*Boiler Control Systems*", McGraw Hill, New York, 1991.
2. Jervis M.J, "*Power Station Instrumentation*", Butterworth Heinemann, Oxford, 1993.
3. Modern Power Station Practice, Vol.6, "*Instrumentation, Controls and Testing*", Pergamon Press, Oxford, 1971.

IC 454 SMART MATERIALS

Review of engineering materials, Different classes of materials: metals, ceramics, polymers and composites, engineering properties, micro structures, structure property correlations, recent development towards novel materials.

Piezoelectric materials: Background, piezoelectricity, industrial piezoelectric materials, smart materials featuring piezoelectric elements.

Shape-memory materials: Background on shape-memory-alloys, continuum applications: structures and machine systems, applications of shape-memory-alloys.

Electro-Rheological (ER) fluids: Suspensions and ER fluids, ER phenomenon, charge migration mechanism, ER fluid actuators, applications of ER fluids.

Magneto-Rheological(MR) fluids: Composition of MR fluid, applications of MR fluids.

Books:

1. Mukesh V Gandhi, Brian S Thompson, "*Smart Materials and Structures*"**,** Kluwer Academic Publishers, 1992.
2. Mel Schwartz**, "***Encyclopedia of smart materials*", John Wiley and Sons, 2001**.**
3. A.V. Srinivasan, D. Michael Mcfarland, "*Smart Structure analysis and design*", Cambridge university press, 2001

RESERVE ELECTIVES

IC 455 OPTIMIZATION TECHNIQUE

Introduction to optimization, Engineering applications, Classical optimization techniques, multivariable optimization with and without equalities, Linear programming – Simplex method, Duality, Karmankar's method, Non linear programming – one dimensional minimization, Geometric programming, Dynamic programming, Queuing theory, Game theory.

Text Books:

1. Kanti Swarup, Gupta,P.K and Man Mohan, "*Operation Research*", Sultan Chand, 11th Edition, 2003.
2. Rao,S.S., "*Optimization: Theory and Applications*", Wiley Eastern,1978.

IC 457 DIGITAL CONTROL SYSTEMS

Introduction to Discrete time systems, analogies with continuous-time systems, mathematical models for LTI discrete-time systems, convolution representation and difference equations in advanced and delayed form, Z-transformation of difference equations, analysis of first, second, and higher order systems, stability of discrete-time systems, the Jury's criterion.

State space modeling of discrete-time dynamical systems, canonical forms, solution to state space equations, properties of the state transition matrix, analysis of discrete-time state equations.

Equilibrium points and stability definitions, direct method of Lyapunov, definitions of controllability and observability, equivalent controllability/observability conditions. Design of state feedback and output feedback control. Design of observers.

Numerical Computations, digital simulation of state-space models, QR decomposition, singular value decomposition, digital control using digital signal processors.

Introduction to Optimal Control, statement of the optimal control problem, dynamic programming, general introduction to the principle of optimality, application to DTS, discrete-time linear quadratic problem, Riccati equation and its solution, optimal state feedback solution.

Text Books:

1. Ogata K., "*Discrete-time Control Systems*", 2nd Edition, Prentice Hall Inc., New Jersey, 1992.
2. Kuo B. C, "*Digital Control Systems*", 2nd Edition, Saunders College Publishing, Japan, 1992.

Reference Books:

1. Phillips C. L. and Nagle H. T, "*Digital Control System Analysis and Design*", 3rd Edition, Prentice-Hall, New Jersey, 1995.
2. Astrom K. J and Wittenmark, "*Computer Controlled Systems Theory and Design*", 2nd Edition, Prentice Hall, New Delhi, 1990.
3. Gopal M., "*Digital Control and State Variable Methods*", Tata McGraw Hill, New Delhi, 1997.

IC 459 ROBOTICS

Introduction: Basic concepts, definition and origin of robotics, different types of robots, robot classification, applications, robot specifications.

Introduction to automation: Components and subsystems, basic building block of automation, manipulator arms, wrists and end-effectors. Transmission elements: Hydraulic, pneumatic and electric drives. Gears, sensors, materials, user interface, machine vision, implications for robot design, controllers.

Kinematics, dynamics and control: Object location, three dimensional transformation matrices, inverse transformation, kinematics and path planning, Jacobian work envelope, manipulator dynamics, dynamic stabilization, position control and force control, present industrial robot control schemes.

Robot programming: Robot programming languages and systems, levels of programming robots, problems peculiar to robot programming, control of industrial robots using PLCs.

Automation and robots: Case studies, multiple robots, machine interface, robots in manufacturing and non-manufacturing applications, robot cell design, selection of a robot.

Text Books:

1. Spong and Vidyasagar, "*Robot Dynamics and Control*", John Wiley & Sons, 1990.
2. Asfahl C.R, "*Robots and Manufacturing Automation*", John Wiley & Sons, New York, 1992.
3. Klafter R.P, Chmiclewski T.A, Negin M, "*Robotics Engineering: Integrated approach*", Prentice Hall, New Jersey, 1994.

Reference Books:

1. Mikell P, Weiss G.M, Nagel R.N and Odrey N.G, "*Industrial Robotics*", McGraw Hill, New York, 1986.
2. Deb S.R, "*Robotics Technology and Flexible Automation*", Tata McGraw Hill, New Delhi, 1994.
3. Isaac Asimov I, "*Robot*", Bahtam Books, New York, 1994.

IC 461 NANO TECHNOLOGY

Background to Nanotechnology, Scientific revolutions, types of nanotechnology and nanomachines, Nano Materials – Atomic structure surfaces and dimensional space. Molecular Nanotechnology.

Nanopowders and Nanomaterials: Introduction, preparation and applications.

CNT: Types, formation / synthesis of nano tubes, applications.

Nanoelectronics: Introduction, tools for nano fabrication, Quantum electronics devices, quantum computers.

Optics and nanotechnology, Nanoholes and photons. Nanoparticles based solar absorbers. Optically useful nanostructured polymers, Nanomechanics, Nanoelasticity and Nanomedicine.

Books:

1. Michael Wilson, Kamali Kannangara,Geoff Smith, Michelk Simon, "*Nanotechnology: Basic science and Emerging technologies*".
2. "*Implications of Micro and Nano technologies*", Committee on Implications- Nanotechnologies, Air Force Science and Technology Board, 2002.
3. Bharat Bhushan, "*Handbook of Nanotechnology*", 1st Edition, Springer, 2004.
4. P Poole, Frank J Owens, "*Introduction to Nanotechnology*", John Wiley and Sons Inc, 2003.

IC 456 FAULT DETECTION AND DIAGNOSIS

Introduction to Fault Detection and Diagnosis: Scope of FDD:- Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches. Classification of Fault and Disturbances- Different issues involved in FDD- Typical applications.

Analytical Redundancy Concepts: Introduction- Mathematical representation of Fault and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation.

Design of Structured Residuals: Introduction- Residual structure of single fault Isolation: Structural and Canonical structures- Residual structure of Multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation.

Design of Directional structured Residuals: Introduction – Directional Specifications: Directional specification with and without disturbances – Parity Equation Implementation – Linearly dependent column.

Advanced level issues and design involved in FDD: Introduction of Residual generation of parametric fault – Robustness Issues –Statistical Testing of Residual generators – Application of Neural and Fuzzy logic schemes in FDD – Case study.

Text Books:

1. Janos J. Gertler " *Fault Detection and Diagnosis in Engineering systems*" – 2nd Edition, Macel Dekker, 1998.

Reference Books:

1. Sachin. C. Patwardhan, "*Fault Detection and Diagnosis in Industrial Process*" – Lecture Notes, IIT Bombay, February 2005.
2. Rami S. Mangoubi, "*Robust Estimation and Failure detection*". Springer-Verlag-London 1998.

IC 458 AUTOMOTIVE CONTROL SYSTEMS

Thermodynamic engine cycles, ideal combustion engines, comparison of different engine concepts, potential of different fuels and propulsion systems.

Basic engine operation, fuel control, ignition control, lambda control, idle-speed control, knock control, combustion torque estimation.

Basic driveline equations, Modeling of neutral gear, State-space formulation, Driveline speed control, Driveline control for gear shifting.

Vehicle modeling, wheel model, tyre characteristics, complete vehicle model, validation of the model, velocity estimation.

Vehicle control system, Antilock Braking Systems (ABS), control cycles of ABS, road model, PID driver model, hybrid driver model, model of human information acquisition, complete driver model.

Text Books:

1. U.Kiencke, and L. Nielson, "*Automotive Control Systems*", Springer Verlag Berlin, 2000

Reference Books:

1. T.Kailath, "*Linear Systems*", Prentice Hall Inc., New Jersy, 1996
2. J.M.Maciejowski, "*Multivariable Feedback Design*", Addison Wesley, Singapore, 1989
3. J.L.Meriam and L.G.Kraige, "*Engineering Mechanics, Dynamics*", John Wiley and sons, 5th Edition, New York, 2002.

IC 460 NEURAL NETWORKS AND FUZZY LOGIC CONTROL

Introduction to neural networks, different architectures of neural networks, Rosenblott's perceptrons, multi layer perceptrons, back propagation algorithm, Hopfield's networks, Kohnen's self organising maps, adaptive resonance theory.

Neural networks for control systems: Schemes of neuro-control, identification and control of dynamical systems, case studies.

Introduction to fuzzy logic: Fuzzy sets, fuzzy relations, fuzzy conditional statements, fuzzy rules, fuzzy learning algorithms.

Fuzzy logic for control systems: Fuzzy logic controllers, fuzzification interface, knowledge/rule base, decision making logic, defuzzification interface, design of fuzzy logic controllers, case studies.

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.

Text Books:

1. Bose and Liang, "*Artificial Neural Networks*", Tata Mcgraw Hill, New Delhi, 1996
2. Kosko, B, "*Neural Networks and Fuzzy Systems: A Dynamical Approach to Machine Intelligence*", Prentice Hall, New Delhi, 1991.
3. Driankov D, Hellendoorn H. and Reinfrank M., "*An Introduction to Fuzzy Control*", Narosa Publishing House, New Delhi, 1996.

Reference Books:

1. S. Haykin, "*Neural Networks: A comprehensive Foundation*", 2nd Edition, Prentice Hall Inc., New Jersey, 1999.
2. Klir G.J and Folger T.A, "*Fuzzy sets, Uncertainty and Information*", Prentice Hall, New Delhi, 1994.
3. Negoita, "*Expert Systems and Fuzzy Systems*", Benjamin Cummings, USA,1985.

IC 462 PIPING & INSTRUMENTATION DIAGRAMS

Flow sheet design: Types of flowsheets, flow sheet presentation, flow sheet symbols, line symbols and designation, process flow diagram, synthesis of steady state flowsheet, flowsheeting software.

Piping and instrumentation diagram evaluation and preparation: P & I D Symbols, line numbering, line schedule, P & I D development, various stages of P & ID-P& ID for pumps, compressors process vessels, absorber, evaporator.

Control systems and interlocks for process operation: Introduction and description, need of interlock, types of interlocks, interlock for pumps, compressor, heater-control system for heater, distillation column, expander.

Instrument line diagram: Line diagram symbols, logic gates, representation of line diagram.

Application of P& ID's: Applications of P& ID in design state, construction stage, commissioning state, operating stage revamping state, applications of P&ID in HAZAPS and risk analysis.

Text Books:

1. Ernest E.Ludwig, "*Applied Process Design for Chemical and Petrochemical Plants Vol-I*", Gulf Publishing Company, Houston, 1989.
2. Max. S. Peters and K.D.Timmerhaus, "*Plant Design and Economics for Chemical Engineers*", 4th Edition, McGraw Hill Inc., New York, 1991.

Reference Books:

1. Anil Kumar, "*Chemical Process Synthesis and Engineering Design*", Tata McGraw Hill, New Delhi, 1982.
2. A.N Westerberg et al., "*Process Flow sheeting*", Cambridge University Press, New Delhi, 1979.

IC 464 RELIABILITY AND SAFETY ENGINEERING

Reliability: Definition and basic concepts, failure data, failure modes, reliability in terms of hazard rates and failure density function. Hazard models and 'bath-tub' curve. Applicability of Weibull distribution. Reliability calculation for series, parallel series and K-out of M systems.

Use of redundancy and system reliability improvement methods.
Maintenance: Objectives, types of maintenance, preventive, condition-based and reliability centered maintenance. Terotechnology, Total Productive Maintenance (TPM).

Maintainability: Definition, basic concepts, relationship between reliability, maintainability and availability, corrective maintenance time distributions and maintainability demonstration. Design considerations for maintainability.

Introduction to life-testing, destructive and non-destructive tests, estimation of parameters for exponential and Weibull distributions, component reliability and MIL standards.

Safety: Causes of failure and unreliability, measurement and prediction of human reliability, human reliability and operator training. Reliability and safety: Safety margins in critical devices. Origins of consumerism and importance of product knowledge, product safety, product liability and product safety improvement program.

Text Books:

1. Govil A.K, "*Reliability Engineering*", Tata McGraw Hill, New Delhi, 1983.
2. Sinha and Kale, "*Introduction to Life-Testing*", Wiley Eastern, New Delhi, 1992.

Reference Books:

1. Wisley et al, "*Human Engineering - Guide for Equipment Designers*", University of California Press, California, 1973.