SYLLABUS

FOR

B.TECH INSTRUMENTATION

SEMESTER 1

IN 101: APPLIED MATHEMATICS 1

- *Module 1*:Co-ordinate geometry of two dimensions: standard equations of parabola, ellipse and hyperbola, their parametric representations, equations of tangents and normal to these curves, simple properties of these curves, asymptotes of a hyperbola, rectangular hyperbola.

- *Module 2*:Co-ordinate geometry of three dimensions: directions cosines, planes and straight lines, shortest distance between two skew lines, sphere, cones, right circular cylinder.

- *Module 3*: Continuity and differentiability of functions of one variable, Roll's theorem, mean value theorem, Cauchy's theorem, and l'hospitals rule for the evaluation of limits of indeterminate forms. Theory of algebraic equations; relations between roots and coefficients of an equation, transformation of equations, Descartes' rule of sign.

- *Module 4*: Functions of two or more variables: partial differentiation, Euler's theorem for homogenous function, differentials and their applications, applications in errors and approximations, Jacobeans. Maxima minima of function of two variables(proof of result is not required).

- *Module 5*: Definite integrals: applications of definite integrals in the evaluation of areas, area of surface of revolution, volumes, moment of inertia, length of arc, position of centre of mass. Multiple integrals: evaluation of double and triple integrals, volumes and surface area of solids using multiple integrals.

- *References:*
  1. B.S.Grewal-Higher Engineering Matehematics-Khanna Publishers.
  2. Erwin kreyzig-Advanced Engineering Mathematics-Wiley Eastern.
  3. S.Balachandran Rao and C.K.Shantha-Differential Calculus-Wiley Eastern.
  4. G.B.Thomas-Calculus and Analytic geometry-Addison Wiley.
  5. S.Narayanan,Manikavachago Pillai and Dr G.Ramanaiah-Advanced Mathematics for Engineering.
  6. N.P.Bali,Dr Ashok Saxena,N.Ch.Sriman Narayana Iyengar-A Textbook on Engineering Mathematics.

IN 102: ENGINEERING PHYSICS

- *Module 1*:Interference of light - analytical treatment of interference- coherent sources- derivation of expression for fringe width in double slit experiment -white light fringes- fringe shift with thin transparent plate- interference on thin films- color of thin films- Newton's rings- air wedge- planeness of surfaces.

- *Module 2*: Diffraction of light - Fresnel and fraunhofer diffraction - zone plates- plane

diffraction grating- measurement of wavelength-dispersive power of grating - resolving power- Ray Leigh's criterion - resolving power of telescope and grating.

- *Module 3*:Polarisation of light- polarization by reflection - refraction- Brewster's law- double refraction- negative and positive crystals-Nichol prism - quarter and half wave plates- production and detection of circularly and elliptically polarized lights- rotatory polarization- half shade polarimeter- applications of polarized light.

- *Module 4*: Nuclear fusion- energy of fusion- chain reaction- concept of critical size- thermal power reactor- breeder reactor-atom bomb fusion- thermonuclear reaction - fusion bomb - particle accelerators - cyclotron- betatron.

- *Module 5*:Wave particle duality-the postulates of quantum mechanics-de broglie 's concept of matter waves-properties of matter waves-Dennison and germer experiment-g.p. Thomson experiment- uncertainty principle-crystal structure- space lattice-unit cell-crystal system-cubic - body centered and face centered cubic - lattice planes- miller indices- spacing between lattice planes-powder method for crystal study- production of x-rays . Continuous and characteristic x rays-Bragg's law.

- *References:*
  1.J.B.Rajam-Modern Physics.
  2.Irving Kaplan-Atomic And Nuclear Physics.
  3.Sathyaprakash-OpticsAnd Atomic Physics.
  4.C.Kittel-Solid State Physics.
  5.B.L.Theraja-Modern Physics.
  6. R.P.Fenyman-Lectures on Physics.

IN103: ENGINEERING CHEMISTRY

- *Module 1*: Atomic orbital-radial probability distribution functions of hydrogen atom-quantum numbers, auf bau principle for much electron atoms-LCACO method for diatomic like N2, CO etc. - basic ideas- hybridizations and molecular shapes. Conjugated systems.

- *Module 2*: Electrochemistry-galvanic cells-EMF measurements, classification of electrodes- Nernst equation- electrode potential cell reaction - relation between cell potential and thermodynamic quantities- Ni-Cd cell - oxygen fuel cell, electron chemical corrosion- cathode protection of metals.

- *Module 3*: Corrosion- theories of corrosion- factors influencing corrosion- corrosion control - cathode protection-protective coatings- metallic coatings - hot dipping - electroplating- metal spraying, cladding. Non metallic coatings - properties and functions of ingredients used in paints, varnishes, enamel and lacquers. - Special paints.

- *Module 4*: Organic chemistry-nucleophile aliphatic substitution- elimination reactions of alkyl halides, nucleophiles- leaving groups: SN2 reaction mechanism, kinetics and stereochemistry, reactivity and steric hindrances, SN reactions, mechanism and kinetics, concept of aromaticity. Huckel's (4n+2) rule.

- *Module 5*:Fuels- classification- calorific value determination of solids, liquids and gaseous fuels- solid fuels, wood , peat , lignite, coal, and coke- proximate analysis of coal- liquid fuels- petroleum and its refining. -fractions and their uses-cracking and reforming-petrol knock and octane number-diesel knock and octane number-synthetic petrol- gaseous fuels-natural gases- acetylene combustion calculation- lubrication and lubricants- theories of friction and mechanism of lubrication- classification and properties of lubricants - production of lubricating oils- synthetic lubricants.

- *References*:
1.Castallan-Physical Chemistry-Addison Wiley.
2.Clasitone and Leivis-Elementary Physical Chemistry.
3.A.Cotton and G.Wilkinson-Advanced Inorganic Chemistry.
4.G.S.Munku-Theoretical principles of inorganic chemistry.
5.Handrickson,Cram and Hammond-Organic Chemistry-Mcgraw Hill.
6.Morrison and Boyd-Organic Chemistry-Prentice Hall India.
7.J.C.Kuriakose and Rajaram-Chemistry in Engineering and Technology,Vol.2.
8.P.C.Jain and Monika-Engineering Chemistry.
9.L.Munree-Chemistry of Engineering Materials.

IN 104: BASIC ELECTRONICS

- *Module 1*: Semiconductors: energy distribution of electrons in a metal- Fermi dirac functions- density of states- electron emission from a metal- carrier concentration in an intrinsic semiconductor- Fermi level in semiconductor having impurities- junction diode: open circuited junction, band structure of open circuited p-n junction, biased p-n junction, V I characteristics, the diode as a circuit element the load line concept, large signal diode models, small signal diode models. Junction diode switching times, tunnel diodes, zener diodes, photodiodes, schottky barrier diodes.

- *Module 2*: Bipolar junction transistor: the junction transistor: physical behaviors of a bipolar transistor, current components. The ebers moll representation of the bjt, the common base configuration, common emitter configuration, cot off and saturation modes.DC models, BJT as an amplifier,BJT small signal models, the BJT as a diode, the emitter coupled pair, BJT ratings.

- *Module 3*:Two port networks- transistors hybrid model - conversion formulas - transistor amplifiers analysis using h parameters- emitter follower- comparison of configurations- millers theorem and its dual - cascading - simplified CE, CC configurations - CE amplifiers with emitter resistance - high input resistance transistor circuits.

- *Module 4*: Transistor biasing: operating point- fixed bias - self bias- bias stabilization- bias compensation- thermal runaway - thermal stability.

- *Module 5*: Effect transistor: the junction field- effect transistor, pinch- off voltage, JFET volt ampere characteristics, FET small signal model, MOSFET, depletion MOSFET, MOSFET gate protection, CMOS. Low frequency common source and common drain amplifiers. Biasing the FET, FET as a voltage variables resistor, the common source amplifier at high frequencies, the common drain amplifier at high frequencies.

- *References*:
  1.Jacob Millman and Arvin Grabel-Microelectronics-Mcgraw Hill.
  2.Jacob Millman and Christos C. Halkias-Integrated Electronics-Tata Mcgraw Hill.

IN 105: ELECTRICAL ENGINEERING

- *Module 1*: Electrostatics: electric charge, coulombs law of electrostatics, electric field, electric potential, capacitor and capacitance. Electromagnetism: magnetic field, biot savartz law, magnetic field of an infinite linear conductor, field strength due to circular loop, field strength inside a solenoid , force on current carrying conductor in a magnetic field, hysterics. Magnetic circuits: magneto motive force, magnetic field strength, reluctance, laws of magnetic circuits, ampere turns of magnetic circuit.

- *Module 2* :Electromagnetic induction: relation between magnetism and electricity, faradays laws of electromagnetic induction , direction of induced emf, magnitude of induced emf in a coil, dynamically induced emf, statically induced emf, growth of current bin inductive circuits , decay of current in inductive circuits. Energy stored in magnetic circuits. Fundamentals of A.C. generation of alternating current and voltages, emf equations, phase and phase difference, rms value, average value, form factor, peak factor, vector diagram A C through capacitor only.

- *Module 3*: A C series circuit: current through resistance and inductance - power factor- active and reactive component of current- Q factor of a coil- A C through resistance and capacitance - dielectric loss and power factor - resonance in R L C circuit. A C parallel circuit: solving parallel circuit- vector method-admittance method - series parallel circuit - resonance in parallel circuits Q factor of a parallel circuit.

- *Module 4*: Mesh and node analysis: kirchoff's laws, source transformation- mesh and node analysis- network equations for RLC networks. Network theorem: superposition theorem -reciprocity theorem- thevenin's theorem- Norton’s theorem - maximum power transfer theorem- substitution theorem.

- *Module 5*:Three phase system: generation of three phase voltage - star connection and delta connection - star/ delta and delta/ star conversion - power in 3 phase system- measurement of 3 phase power in balanced and unbalanced system. Symmetrical components: positive sequence components , negative sequence components and sequence components.

- *Referencs*:
  1.V.N.Mittel-Basic Electrical Engineering-Tata Mcgraw Hill.
  2.B.L.Theraja-A Textbook of Eletrical Technology,Vol 1.
  3.D.Roy Choudhary-Network and Systems-New Age International Publishers.

IN 106: PRACTICALS

1. ENGINEERING GRAPHICS

- *Module 1*: Introduction to engineering graphics: drawing instruments and their use, familiarization with current Indian Standard Code of practice for general engineering drawing. Scales- plane scale, vernier scale, diagonal scale. Conic sections- constructions of ellipse, parabola, hyperbola, involutes- drawing tangents and normals to these curves.

- *Module 2*: Orthographic projection: planes of projection, principles of first angle and third angle projections, projection of point s in different quadrants. Projection of straight lines parallel to one plane and inclined to the other plane- straight lines inclined to both the planes- true length and inclination of lines with reference planes - traces of lines. Projection of plane lamina of geometrical shapes in oblique positions

- *Module 3*: Projection of solids- simple solids in simple position- development of surfaces and solids - development of frustum of cone, cylinder and prism. Isometric projection of prisms pyramids and sphere.

- *Module 4*: Introduction to machine drawing: BIS convention - screw threads- nuts and bolts. Riveted joints

- *Module 5*: Bearings- simple, bush and thrust bearings. Shaft couplings- muff, flanged and flexible couplings.

- *References*:
  1.N.D.Bhatt-Engineering Drawing-Charotar Publishing House.
  2.P.I.Varghese and K.C.John-Engineering Graphics-Jovast Publishers.
  3.N.D.Bhatt and V.M.Panchal-Machine Drawing-Charootar Publishers.
  4.P.I.Varghese and K.C.John-Machine Drawing-Vip Publishers.

2. MECHANICAL AND ELECTRICAL WORKSHOP:

Welding
Bench work and fitting
Carpentry
Simple exercises in lathe, milling machine, shaping machine
Grinding and sheet metal works
Class work familiarization
Staircase wiring
Hospital wiring
Go down wiring
Fluorescent lamp

SEMESTER 2

IN 201: APPLIED MATHEMATICS

- *Module 1*: Matrix Algebra: Rank of a Matrix, Normal form, linear systems of algebraic equations, consistency, and homogenous system of equations, linear transformation, orthogonal transformation, Eigen Values and Eigen vectors. Cayley Hamilton theorem, Digitalization- real symmetric matrix and quadratic forms.

- *Module 2*: Vector Calculus: Vector differential calculus: Scalar and vector point functions, gradient, divergence and curl, their physical interpretation. Vector Integral Calculus: Line, Surface and volume integrals, Gauss's divergence theorem, Stoke's theorem(No proof for these theorems), Conservative force fields, Scalar potential.

- *Module 3*: Laplace Transforms: Definitions, transforms of elementary functions, inverse transforms of derivatives and integrals, differentiation and integration of transforms, convolution theorem, Use of Laplace transforms in the solution if initial value problems, unit step function, impulse function, transforms of step functions, transforms of periodic functions.

- *Module 4*: Convergence and divergence of infinite series: Integral test, comparison test, ratio test, Cauchy's root test, Raube's test, series of positive and negative terms, concept of absolute convergence, alternating series, Leibniz test(No proof for any of the above test). Power series: Convergence of power series, Taylor and Maclaurin series of functions, Leibniz formula for the derivative of the product of two functions(No proof).Use of leibniz formula for the determination of coefficients of power series.

- *Module 5*: Ordinary differential equation: Solution of a first order differential equation, equations with seperable variables,homogenous differential equation,exact differential equation,linear equations with constants coefficients, method of solution of differential equations.

- *References*:
  1.B.S.Grewal-Higher Engineering Mathematics.
  2.Erwin Kreyzig-Advanced Engineering Mathematics.
  3. S.Narayanan,Manikavachago Pillai and Dr G.Ramanaiah-Advanced Mathematics for Engineering.
  4.David Lewis-Matrix Theory-Allied Publishers.
  5.R.V.Chuchill-Operational Mathematics-Mcgraw Hill.
  6.Kaplan W –Operational Methods for Linear Systems-Addison Wiley.

IN 202: ANALOG ELECTRONICS

- *Module 1*: Elementary diode application: Rectifiers, voltage equations, simple zener regulator, regulated power supplies-series voltage regulator. Wave shaping circuits: linear wave shaping, clipping and comparator circuits clamping and switching circuits.

- *Module 2*:Transistor at high frequencies: hybrid –pi CE transistor module,CB short circuit current gain , single stage CE transistor amplifier response, gain –bandwidth product ,emitter –flower at high response, multistage amplifier :classification distortion in amplifiers, frequency response, bode plote,step response, band pass of cascaded stages,RC coupled amplifier-low frequency response, high frequency frequency response of two cascade CE stages, multistage CE amplifier cascades at high frequencies.

- *Module 3*: Power amplification classification-Class A, Class B, Class AB and Class C – transformer less class AB, push pull power amplifier, complimentary symmetry power amplifier –harmonic distortion in power amplifiers.

- *Module 4*: DC amplifier direct coupled amplifier-FET DC amplifier –zener diode biasing for DC amplifier-cascade amplifier-Darlington emitter follower-boot strapped Darlington circuit .amplifier noise: thermal noise. FET noise- interference – shielding and grounding – eliminating interference – Capacitive coupling – Magnetic coupling ratio frequency coupling.

- *Module 5*:Integrated circuits: Fabrication and characteristics – Integrated circuit technology – Monolithic integrated circuits – Epitaxial growth – Masking and etching – Diffusion of impurities – Transistors for monolithic diodes – Integrated resisters , capacitors and inductors – Circuit layout – LSI and MSI – The metal – Semiconductor contact.

- *References*:

  1. Jacob Millman and Christos C. Halkias-Integrated Electronics-Tata Mcgraw Hill.
  2. Millman and Taub-Pulse,digital and switching wave forms-Tata Mcgraw Hill.

IN 203: ELECTRICAL ENGINEERING 2

- Module 1:Transformer : working principal of ideal transformer –construction feature – emf equation –vector diagram –equivalent circuit impedance transformer –transformer losses –flux leakage –efficiency-open circuit and short circuit testes-auto transformer – working principal and saving of copper –basic idea of current transformer and potential transformer.

- Module 2: DC machines: type of D.C. machines, emf generator in the armature, and torque in D.C. machines method of extraction, mmf and flux density wave form in d.c machines, commutation process, compensation process, compensating winding, magnetization curve, effect of armature mmf on d.c.machines calculation. Operating characteristics of D.C. generators and motors. DC motor starting, speed control of D.C. machines-DC machines application.

- Module 3: Alternator: rotating field, speed and frequency – effect of distribution of winding –emf equation-losses and efficiency equation-emf and mmf methods, synchronous motor –torque equation –starting method-effect of over /under excitation.

- Module 4: Induction motor: three phase induction motor –constructional features-principal of operation-vector diagram and equivalent circuit-performance calculation using circle diagram-starting and speed control of squirrel cage and wound rotor induction motor. Single phase induction motor: principal of operation, steeper motor, universal motor - hysteresis motor.

- Module 5: Introduction of generator of electric Power: hydroelectric, nuclear, diesel, gas power station. Element of transmission and distribution of electric power-practical working voltage-underground system and overhead system –typical power scheme – different system of transmission and circuit-different type of line insulator used. Switch gear and protection: requirement of circuit breaker, types of circuit breaker.Basic principle of operation of circuit breaker.

- *References*:
  1.P.S.Bimbhra-Electrical Machinary –Khanna Publishers.
  2.S.L.Uppal-Electrical Power-Khanna Publishers.

IN 204: ENGINEERING MECHANICS

- *Module 1*:Statics:- Concurrent forces in a plane - principal of statics – composition and resolution of forces – equilibrium of concurrent forces in a plane - Method of projections – equilibrium of three forces in a plane – Method of moments. Parallel forces in a plane: - Two parallel forces – general case of parallel forces in a plane – centre of two parallel forces and centre of gravity – centroids of composite plane figures and curves – distributed forces in a plane - Moment of inertia.

- *Module 2*: General case of forces in a plane: composition of forces in a plane – equilibrium of forces in a plane - plane trusses – method of joints and method of sections - plane frames – method of members.

- *Module 3*:Rectilinear translation: Kinematics of rectilinear motion – differential equation of rectilinear motion – motion of particles acted upon by a constant force – force as a function of time force proportional to displacement – D' Alemberts principle – momentum and impulse - work and energy – ideal systems – conversion of energy – impact – curvilinear motion - kinematics of curvilinear motion – differential equation - motion of projectile – kinematics of rotation – equation of rigid body rotating about a fixed axes – rotation under the axis of constant moment – compound pendulum – general cases of moments proportional to the angle of rotation.

- *Module 4*:Stress and strain – concept of stress – equation of equilibrium – stresses in axially loaded member – concept of strain – Hook's law of isotropic materials – elastic constants – thermal strain – elastic strain energy – idealized stress strain diagram – deflection of axially loaded members – transformation of plane stress - principle stresses – Mohr's circles of stress - measurement of surface strains – Rosettes.

- *Module 5*: Bending stresses in beam: shear forces and bending moment diagrams-basic assumptions in bending-elastic flexure formula-application of flexure formula-torsion of circular members: basic assumptions-torsion formula- angle of twist- deflection of beams: governing differential equation go deflections- solution by direct integration.

- *References*:
1.Timsohenkov and Yound-Engineering Mechanics-Mcgraw Hill Book Co.
2.Egor.P.Popov-Introduction to Mechanics of Solids-Prentice Hall Publishers.
3.Laughaar and A.P.Boresi-Engineering Mechanics-Mcgraw Hill Book Co.
4.Irwing Shames-Engineering Mechanics-Prentice Hall of India Pvt. Ltd.

IN 205: MATERIAL SCIENCE

- *Module 1*: Engineering aspects of materials-structure of materials- Chemical Bonding-Crystal Structure- X-ray diffraction- Bragg's law- Defects and Dislocations in solids-Diffusion in solids- fick's law.

- *Module 2*: Phase diagrams-Phase rule-single component systems-binary phase diagrams-applications of phase diagrams-mechanical poperties of materials-Elasticity-Stress-Strain- Hook's Law- Viscosity-Plastic deformation-creep-fracture-mechanical testing of materials.Hardness and Fatigue testing.

- *Module 3*:Electrical Properties of Materials-Free electrons in solids-metallic conductivity-resistivity-elements of Band Theory- Semiconductors- Intrinsic and extrinsic – p-n junction –Semiconductor materials- Superconductivity – Basic ideas-Magnetic Properties of Materials-Dimagnetism-Paramagnetism and ferromagnetism-Langevin theory-magnetic materials.

- *Module 4*: Dielectrics and ferroelectrics - Polarization types–classification of dielectrics – Piezoelectricity – Ferro electricity –Dielectric behaviour-permittivity- Oxidation and Corrosion.-Mechanism of oxidation-protection against corrosion.

- *Module 5*: Ceramics and Composites – Classification –Modern ceramic materials-cements – Glass ceramics – Glass fiber – Carbon Fibers – Whiskers – Thermoplastics – Thermoset Materials – Polymers- Polymerization techniques-natural and synthetic rubbers-Plastics – Composites-FRP and CFRP materials-engineering applications.

- *References*:
1.V.Raghavan-Materials Science and Engineering-Prentice Hall of India.
2.Choudhary-Materials Sciences and Processes-Indian Book Distributors.
3.A.G.Guy-Essentials of Materials Science-Mcgraw Hill.
4.Van Vleck-Elements of Materials Science-Addison Wiley.

IN 206: PRACTICALS

1. BASIC ELECTRONICS LAB

- Characteristics of diodes
- Zener diode, transistor characteristics (CB and CE configuration)
- Bias and Bias Stabilization
- FET characteristics
- Design of FET amplifiers
- Frequency response.

2. C PROGRAMMING

Structure of a C program.

C Fundamentals-character set,identifiers,keywords,dattypes,operators,expressions,library Functions,input and output statements.control statements,conditional expression,loop Statement,breaking control statement.

Arrays -actual notation,declaration,initialisation,processing with arrays,mutidimensional Array,character array.

Function – actual and formal argument, local and global variable, multifunction program, Recursive functions.

Structures -declaration of structures, initializing a structure,functions,arrays within a Structure,structure within a structures unions.

Pointers –declaration,pointer and function,pointer and arrays, pointer and strings,pointers And structures.

Data files –opening and closing a data file,creating a data file.

References:

1.Kerningham and Ritche-C Programming

SEMESTER 3

IN 301: APPLIED MATHEMATICS

- *Module 1*: Fourier series and Fourier Integrals: periodic Functions, Euler formula for Fourier coefficient, function having arbitrary period. Even and odd function, half range expression, Fourier integral. Gamma and beta function: Error function, definitions and simple properties

- *Module 2*: Partial differential eqation:solution of non-linear partial differential equations of the form f(p,q)=0,f(x,p,q)=0,f(y,p,q)=0,f(z,p,q,)=0,f1(x,p)=f2(y,p,),Lagrange's form Pp+Qq=R. Application of partial differential equation: vibrating string-one dimensional wave equation, D'Alemberts solution, solution by the method of separation of variables, one dimensional heat equations solution of the equation by the method of separation of variables, solution of Laplace equations over a rectangular region and circular region by method of separation of variables.

- *Module 3*:Probability and Statistics: Definition of probability, random variables and expectation, Addition multiplication theorem and Bayes's theorem, binomial distribution,hypergeometric distribution,Chebyshev's theorem, Poisson Approximation to Binomial distribution. Probability densities: continuous random variable, uniform distribution, normal distribution, gamma distribution, lognormal and weibull distribution (derivation of formula for lognormal, weibull, gamma distribution not required).

- *Module 4*:Sampling distribution: populations and samples, the sampling distribution of means, the sampling distribution of variance, point estimation, interval estimation test of hypothesis , null hypothesis and significance tests ,hypothesis concerning one mean , type 1 and type 2 errors, hypothesis concerning two means.

- *Module 5*: The estimation of variances - hypothesis concerning one variance, hypothesis concerning two variance, curve fitting -method of least squares, correlation and regression, lines of regression.

Note: Derivations of various sampling distributions and their mean,variances etc. are not required. Treatmaent of topics in *Module 3,Module 4 and Module 5* should be oriented towards problems involving real life

- *References*:

1. B.S.Grewal:
   Higher Engineering Mathematics.
2. S.Narayanan, T.K.Manichavachagom Pillai, Dr. G. Ramaniah:
   Advanced Mathematics for Engineering Students.
3. Millers and Freund's Probability and Statistics for Engineers:
   Prentice Hall of India.
4. E.Parzen: Modern Probability Theory and its Applications
   Wiley Eastern.
5. Erwin Kreyszig: Advanced Engineering Mathematics
   Wiley Eastern.

IN-302: DIGITAL ELECTRONICS

- *Module 1*:Number system and codes- Binary ,Octal , Hexadecimal number systems and number system- four bit BCD codes , weighted codes , Excess-3 code, Gray code , Self complementing codes , Error detecting codes and error correcting codes -Hamming code -Code conversions -Parity checking.

- *Module 2*:Logic gates - AND ,OR , NOT, XOR , NAND , NOR, logic families - RTL, DTL , TTL, IIL, CMOS logic, ECL , TTL characteristics -open collector TTL, -Tristate logic ,-TTL subfamilies ,Boolean algebra , de Morgan's theorem ,laws of Boolean algebra , Karnaugh mapping, Simplification of Boolean expression.

- *Module 3*:Combinational systems -Encoders ,Decoders, Comparator , Multiplexer and Demultiplexer -half and full adders , serial and parallel adders , addition and subtraction by 1's and 2's complement method- bcd adder -flip-flops - RS , JK , Master slave ,D-type , T-type Flip Flop timings .

- *Module 4*:Shift registers - parallel to serial and serial to parallel converters - Counters - Ring ,Ripple, Johnson counters, mode N counter - synchronous sequential system - State minimization - Implication chart - Fundamental nodes - Races and Hazards - Presettable counters - Shift counters - Digital clock

- *Module 5*:Semiconductor memories -memory addressing –ROMs and EPROMs – RAM-s dynamic RAMs –Memory cells- Implementing logic functions using MSI and programmable devices - Designing with multiplexers - Logic functions with MSI decoders - using XOR and XNOR elements - using programmable devices - PROM – PAL-PLA- Muti-level PLDs

- *References:*

1. Malvino and Leach – Digital Principles and Applications.
2. Richard Sandige – Moder digital Design – McGraw Hill

IN 303 - LINEAR INTEGRATED CIRCUIT

- *Module 1*:Feedback amplifier - Concept of feedback – types of feedback position and negative feedback effect of feedback on amplifier - expression and derivation - voltage current - series -shunt - typical circuits -frequency response ,band width and comparison , Oscillators ,concept of positive feedback -types of oscillators -Barkhausen criteria -RC phase shift oscillation- Principle -analysis and design- Principle of operation of Hartley, Colpitts ,crystal oscillator (analysis and design).

- *Module 2*:Operational amplifier -The basic Op Amp -The differential amplifier-Emitter coupled differential amplifier -Transfer characteristics –An I.C. Op Amp -offset voltage and currents -Temperature drift -Op Amp parameters -Frequency response of an Op Amp - Dominant pole - Pole zero and lead compensation -step response.

- *Module 3*:Applications of Op Amps - Inverting and non inverting amplifier - Differential d.c. amplifier -Instrumentation amplifier -Stable A.C. coupled amplifier -Analog integration and differentiation - Analog computation -Solution of differential equations - Active filters - Active resonant band pass filters.

- *Module 4* :Nonlinear analog systems -Comparators -Sample and hold circuits - precision a.c/d.c converters -Logarithmic and Antilogarithmic amplifiers -waveform generators - AMV, MMV and PMV -Regenerative comparators -Multipliers and their applications .

- *Module 5*:Monolithic regulators - switched mode power supplies – Principles and applications - Switching regulators - Phase locked loops and their applications - Introduction to PLL-Operating principle and classification - The linear PLL -Building blocks - linear PLL performance in locked state - order of the LPLL - parameters of the PLL – Noise – LPLL applications

- *References*:

1. Millman and Halkias - Integrated Electronics,McGraw Hill
2. R.E.Best - Phase-Locked Loops,Theory,Design and Applications- McGraw Hill.
3. I.R.Sinclair - Electronic Power Supply Handbook-RPB publications

IN 304: ELECTRICAL AND ELECTRONIC INSTRUMENTS

- *Module 1*: Measurement and measuring systems: SI units - Significance of measurements - method of measurements- type of instruments- classification of instruments- functions of instruments and measurement system. Measurement and error: Accuracy and precision - significant figures - types of errors - statistical analysis - probability of errors - limiting errors.

- *Module 2*:Potentiometers - general principles - use of d.c potentiometer in the

measurement of voltage , current , resistance and power - calibration of ammeter , voltmeter , wattmeter - a.c potentiometers - use of a.c potentiometers in magnetic measurements- measurement of low and medium resistance - bridge methods - measurement of high resistance - insulation to the measurement of inductance and capacitance- bridge methods.

- *Module 3*:Magnetic measurements: Classification of magnetic measurements- measurement of flux density and magnetizing force - magnetic potentiometers - determination of B.H curve - hysteresis loop - testing of bar and ring specimens - parameters - separation and measurement of iron loss - measurement of air gap flux - testing of permanent magnets.

- *Module 4*:Electrical instruments : Constructional details - dynamic behaviors of D' Arson Val galvanometer- galvanometer sensitivity - PMMC type - MI type - dynamometer type - induction type measurement of current voltage and resistance - multimeters - power and energy measurements - single phase and poly phase meters - instrument transformers.

- *Module 5*:Electrical instruments : C.R.O- block diagram - CRT circuit - vertical deflection system - delay line - multiple trace - horizontal deflection system - oscilloscope probes and transducers - oscilloscope techniques - storage oscilloscope - sampling oscilloscope.

- *References*:

1. Albert.D.Helfrick and William.D.Cooper-Modern electronic instrumentation and measurement techniques-Prentice Hall of India Ltd.
2. A.K.Sawhney - -Electrical and electronic measurements and instrumentataion – Dhanpat Rai & Sons

IN 305: MECHANICAL ENGINEERING

- *Module 1*:Internal Combustion Engine: Classification of IC engines - Engine components - Four stroke engine - two strike engine - Petrol and diesel engines - Fuel supply and injection system in diesel engines - Carburetion in petrol engines - ignition system in petrol engines - Cooling of IC engines - Lubrication of IC engines - Engine power - Testing of IC engines.

- *Module 2*:Steam generators : Properties of steam classification of boilers - Five tube and water tube boiler - Simple vertical boiler - Cochran boiler - Lanchashire boiler - Locomotive boiler - Babcock and Wilcox boiler - La - Mont boiler.
  Boiler mountings and accessories: Boiler mountings: water gauge and water level indicator - Pressure gauge - Steam stop valve - Feed check valve - blow down cock - Fusible plug - Spring loaded safety valve - Dead weight safety valve - lever safety valve -High steam and low water safety valve.
  Accessories: Pressure reducing valve - Steam traps -Steam separator - Economizer - Feed pump injector.

- *Module 3*: Steam engine and turbines: Classification of steam engines - Working indicator diagram - Work done. Steam turbines - Classification of steam turbines - Simple impulse turbine - Velocity diagram - Reaction turbine - compounding of impulse turbine

- Advantages of steam turbines over steam engines.

- *Module 4*: Air compressors: Reciprocating air compressors - Mechanical details - Shaft work - Multistage air compressors with intercooling.
  Introduction to condensers and cooling towers. Refrigeration: Types of refrigerators - refrigerating effect and unit of refrigeration - Vapor compression refrigerator - Vapor absorption refrigerator - refrigerants.

- *Module 5*: Mechanical power transmission: Belt drives - slip and velocity - length of belt - ratio of belt tensions - Power transmitted by belt drives - rope drives - chain drives - gear drives.
  Primary shaping processors: Moulding and casting - Forging - Rolling - extrusion- wire drawing - coining- blanking -punching.
  Metal joining processors: welding - brazing - soldering.

- *References*:
  1. P.L.Balsaney – Thermal Engineering - - Khanna Publishers
  2. P.Balachandran and J.Benjamin – Afirst Course in Mechanical Engineering – Jalagandeesh Publications.
  3. S.K.Hajra Choudhury and A.K.Hajra Choudhury – Elements of Workshop Technology - Media Promoters and Publishers Pvt.Ltd.

IN 306: PRACTICAL

1. ANALOG ELETRONICS LAB

Half wave and full wave rectifiers-regulation and ripple characteristics with and without filter
Design of RC coupled CE transistor amplifiers.
Design of series voltage regulator.
Characteristics of UJT relaxation oscillator .
Class A Class B power amplifers.
Design of emitter-frequency response-effect of carrying load resistance on output voltage
Clipping and Clamping circuits.
Different type of power supplies-design and performance analysis.
Control of power using SCR .Triac, and power transistor.
Operational amplifiers -inverting, non inverting, differential amplifiers, instrumentation amplifier -CMMR
Summer, differentiator, integrator, logarithmic, antilogarithmic amplifers.
Function generator using Op Amp.
Active filters using op amps.
555 circuits, phase locked loop.

2. ELECTRICAL MACHINE AND MEASUREMENT LAB

Load test on D.C.shunt motor
Load test on D.C. shunt generator.
Open test and load test on separately excited D.C. generator,
Load test on D.C. series motor
Load test on d.c shunt generator.
Torque slip characteristics of ingle phase induction motor.
Circle diagram of three phase induction motor.
No load characteristics of single phase generator.
O.C.C and S.C.C of three phase synchronous generator.
Open circuit and short circuit of single phase transformer.
Calibration of ammeter and voltmeter using precision potentiometer.
Testing of energy meter.
Measurements of 3 phase power using two wattmeter methods.
Measurement of power factor.
Kelvin's double bridge.

SEMESTER 4

IN 401: APPLIED MATHEMATICS

- *Module 1*: Complex analysis: curves and regions in the complex plane, complex functions, limit, derivative, analytic functions, Cauchy-Riemann equations, elementary complex functions such as powers, exponential functions, logarithmic, trigonometric and hyperbolic functions. Conformal mapping: Linear fractional transformations, mapping by elementary functions like ez, sin z, cos z, sin hz, and cos hz, Schwarz - Christoffel transformation.

- *Module 2*: Numerical Analysis: Errors in numerical computations, sources of errors, significant digits.
  Numerical solution of algebraic and transcendental equations: bisection method, regula falsi method, Newton -Raphson method, method of iteration, rates of convergence of this method, graffe's root squaring method for roots of algebraic equations.
  Solution of system of linear algebraic equations: Exact methods, Gauss elimination method, Grout's triangularisation method, Gauss-Jacobi and Gauss Seidel iteration Methods, Relaxation method.

- *Module 3*: Polynomial interpolation: Lagrange interpolation polynomial, divided differences, Newton's divided difference interpolation polynomial. Finite differences: Operators, Newton's forward and backward differences interpolation Polynomials, central differences, Stirlings central differences interpolation polynomial.
  Numerical differentiation: Formulae for derivatives in the case of equally spaced points.
  Numerical integration: Trapezoidal and Simpson's rule,compound rules,Errors of interpolation and integratiom formulae.

- *Module 4*:Numerical solution of ordinary differential equations: single step methods, Taylor series method, Euler's method, modified Euler's method, Picards method, Runge-Kutta formulae of 2^{nd} , 3^{rd} and 4th order (derivation), multistep method, Milne's predictor corrector method, Adam's method.

- *Module 5*: Solution of linear difference equations with constant co-efficient: Numerical solution of boundary value problems, methods of finite differences, finite differences

methods for solving Lap lace's equation in a rectangular region, finite differences methods for solving the wave equation and heat equation.

- *References*:

1. S.Narayanan, T.K.Manichavachagom Pillai, Dr. G. Ramaniah: Advanced Mathematics for Engineering Students– S.Viswanathan Publishers
2. Erwin Kreyszig: Advanced Engineering Mathematics-Wiley Eastern
3. S.S.Shastry – Introductory method of Numerical Analysis –Prentice Hall of India
4. M.K.Jain,S.R.K. Iyenger, R.K. Jain – Numerical Method for Scientific and Engineering Computation – Wiley Eastern.
5. Ralph.G.Statonn –Numerical method for Science and Technology
6. Gerald – Applied Numerical Analysis – Addison Wesley
7. P.Kandaswamy,Thilagavathy,Gunavathy – Numerical Methods – S.Chand & Co.
8. E.V.Krishnamoorthy and S.K.Sen – Numerical Algorithm – Affiliated East. West.

IN 402: PRINCIPLES OF MEASUREMENT AND INSTRUMENTATION

- *Module 1*:Static and dynamic characteristics-review of static characteristics-loading effect of instruments-Generalized mathematical model of measurement systems-Operational transfer function- Zero , first and second order instruments- impulse, ramp, step and frequency response- response to periodic input- dynamic calibration.

- *Module 2*: Signals and noise-deterministic and random signals- periodic and a periodic signals-bandwidth-signal conditioning and processing- filtering-passive and active filters-types of filters-frequency transformation-signal analysis, frequency analysis-applications.

- *Module 3*: Data acquisition systems: objectives of DAS, elements of analog DAS, elements of digital DAS, elementary treatment of A/D and D/A conversion- data loggers-elements of microprocessors and PC based DAS.

- *Module 4*: Data presentation elements - Review and choice of data presentation elements-pointer, scale indicators, analog chart recorders, alphanumeric displays- printers-magnetic tape recorders-LCD devices- digital meters-resolution, sensitivity-digital voltmeter-digital frequency meter.

- *Module 5*: Data transmission and telemetry-characteristics of a telemetry system-modulation, land-line telemetry-radio telemetry-frequency division multiplexing-Time division multiplexing.

- *References*:

1. D.V.S. Murthy – Transducers and Instrumentation – Prentice Hall India-
2. C.S. Rangan,G.R. Sarma and V.S.V. Mani – Instrumentation Devices and Systems – Tata McGraw Hill
3. Doeblin – Measurement Systems Application and Design – McGraw Hill.
4. Bentley – Principles of Measurement System – Longman Scientific & Technical.

IN 403: CONTROL ENGINEERING 1

- *Module 1*:Introduction:basic ideas of control systems and their classification- differential equations of physical systems-mechanical, electrical, thermal and fluid systems-transfer function-block diagram, signal flow graphs- illustrative examples.
  Feedback characteristics of control systems- feedback and non-feedback systems-reduction of parameter variation by use of feedback – control over system dynamics by use of feedback- control of the effects of disturbance signals by use of feedback-regenerative feedback- illustrative feedback.

- *Module 2*: Time domain analysis: design specifications and performance indices- types of test inputs- time response of 1st and 2^{nd} order systems- steady state error and error constants- effect of adding a zero to a system design. Specifications of a 2^{nd} order system-design. Consideration for higher order systems.
  Concept of stability- conditions- Routh Hurwitz criterion.

- *Module 3*: Frequency domain analysis-correlation between time and frequency response-polar plot-bode plot-all phase and minimum phase system- experimental determination of transfer functions-log magnitudes vs. phase plots- Nichol's chart stability in frequency domain- Nyquist stability criterion- relative stability- Sensitivity analysis in frequency domain.

- *Module 4*: Root locus technique concept- basic theory and properties of root loci-construction of root loci -stability in terms of root loci-generalized root locus diagram-root contours-system with transportation lag-sensitivity of the roots of characteristic equation.

- *Module 5*: Introduction to design considerations in classical design- Realization of basic compensations-Cascade compensation in time domain - cascade compensation in frequency domain. Feedback compensation – Network compensation of AC systems.

- *References*:

1. Nagarath and Gopal – Control Systems Engineering – Wiley Eastern.
2. Kashusiko Ogata – Modern Control Engineering.
3. Benjamin.C.Kuo – Automatic Control Systems.
4. Dr. Sushil Das Gupta – Control Engineering

IN 404: POWER ELECTRONICS

- *Module 1:* Thyristor: terminal characteristics of thyristors, thyristor ratings- thyristor protection- series and parallel operation of thyristors. Other members of thyristor family: PUT, SUSI, LASCR, diac, triac, ASCR, RCT, and GTSO. Firing circuits for thyristors.

- *Module 2*: Phase controlled rectifiers: half wave circuit with RL load, half wave circuit with RL load and free wheeling diode, half wave circuit with RLE load. Full wave controller converters, single phase full wave converters, single phase two pulse converters with discontinuous load current- three phase converter system using diodes- three phase thyristor converter circuits- effect of source impedance on the performance of the converters - Dual Converters.

- *Module* 3: Step up choppers – Choppers: principle of chopper operation- control strategies- types of chopper circuits- steady state time domain. Analysis of type a chopper - thyristor. Commutation in chopper circuits- multiphase choppers.

- *Module 4:* Inverters: single phase voltage source inverters- three phase bridge Inverters. Voltage control in single phase Inverters .pulse width modulated Inverters. Reduction in harmonics Inverter output voltage- current source Inverters.

- *Module 5*: AC voltage controllers: types of ac voltage controllers- single phase voltage controllers- sequence control of AC voltage controllers. Cycloconverters: principle of cycle converter operation- three phase half wave Cycloconverters .Output voltage equation for a Cycloconverter.

- *References*:

1. P.S.Bimbhra – Power Electronics – Khanna Publishers.
2. M.Ramamoorthy – An Introduction to Thyristors and Their Applications East West Press
3. Chute and R.D.Chute – Electronics in Industry – McGraw Hill

IN 405: PNEUMATIC AND HYDRAULIC SYSYTEMS

- *Module 1*: Comparison of pneumatics, fluidics and electronics - pneumatic power supply- compressor schemes of instrument air production- distribution filters- regulators.

- *Module 2*: Steady state flow of ideal gases- weight flow equation- Mach number- orifice. Nozzle and valve flow calculation- discharge coefficient – capillary flow- viscous flow equations with parallel plates, circular tube- flow of real gases- linearized flow equations.

- *Module* 3:Steady state analysis of pneumatic components- multiple restrictions, volume calculation sensing chamber- valves-alternators- transients in pneumatic systems- pneumatic cylinders- speed control spool valves- directional control valves- popped valves- slide valves- solenoid valves- quick exhaust valve- brief survey of other types of valves and associated components.

- *Module 4*: Pneumatic control circuits and systems- manual control of pneumatic cylinders- use of five and four port valves and their characteristics- pilot operated circuits- sequence operation of two cylinders- three and more cylinders

- *Module 5*: Elements of hydraulic systems- advantages and disadvantages- service properties of hydraulic fluids - qualities of an ideal hydraulic fluid- additives- filters and strainers- fluid seals – hydraulic symbols- hydraulic accumulators- fluid power pumps- hydraulic jack- hydraulic lift.

- *References*:

1. W.A.Blaine – Analysis and design of Pneumatic system – John Wiley and sons
2. S.C. Rangwala – Fluid Mechanics – Charotar Publishing House
3. F.K.Kay – Pneumatic Circuit Design – Machinery Publishing Company.
4. Pnematic Circuits and Low Weight Automation – Trade and Technical Press,England.
5. Principles and Theory of Pneumatics – Trade and Technical Press Ltd.,England

IN 406: PRACTICALS

1: DIGITAL ELECTRONICS LAB

Binary adder/ subtractor
Digital comparator
Shift registers
Counters
IC timer
LED and 7 segment display
Encoders and decoders
Multiplexers and Demultiplexer
Semiconductor RAM
EPROM

2: MATERIAL SCIENCE LAB

XRD analysis
Hall Effect measurements
Electrical resistivity measurements
Characterization of polymer materials
Galvanic corrosion of materials and thermodynamic parameters
Tension test
Torsion test
Testing of springs
Impact test
Hardness test
Fatigue test
Performance test on 4 stroke engine
Viscosity determination
Moment of inertia of connecting rods
Determination of the effectiveness of a parallel and counter flow in a heat exchanger
Valve timing of a four stroke engine and port timing of a 2 stroke engine

SEMESTER 5

IN 501: CONTROL ENGINEERING

- *Module 1:* Sample data control systems, spectrum analysis of sampling process, signal reconstruction – difference equation.Z transformation – Z and pulse transfer function-inverse z transfer and response of linear. Discrete system –Z transform analysis of sample-data control system response between sampling instant- Z and S domain relationships-stability analysis-compensation techniques by continuous network time domain techniques-selection of sampling frequency.

- *Module 2:* State variable analysis and design- concept of state, state variable and state model – state variable representation of SISO and MIMO system – phase variable and canonical methods – state transition matrix , solution of state equation. Concept of controllability and observability - pole placement by state feedback, state variables and linear discrete – time system.

- *Module 3*: Optimal control system – parameter optimization, servo mechanism – optimal control problem – transfer function approaches and state variable approaches – the state regulator problem – the infinite time regulator problem – the output regulator and tracking problem – parameter optimization (regulator)

- *Module 4*: Nonlinear system – common physical nonlinearities – phase plane method – basic concepts – singular points – stability of nonlinear system – construction of phase trajectories – system analysis by phase plane method – the describing function method – jump resonance – Liapunov stability criteria – Popov stability criteria

- *Module 5*: Stochastic optimal linear estimation and control – stochastic process and linear system, optimal estimation for linear continuous time and discrete time system. Stochastic optimal linear regulator – discrete adaptive control.

- *References*:

1. Gopal - Digital Control Engineering
2. Nagarath and Gopal – Control Systems Engineering
3. Gibson – Nonlinear Control

IN 502: TRANSDUCERS AND INDUSTRIAL INSTRUMENTATION I

- *Module 1*:Measurement of temperature – temperature scale – primary and secondary standards for calibration – different types of filled system thermometers – installation maintenance, source of errors – bimetallic thermometers – installation maintenance, source of errors – bimetallic thermometer – thermocouples – materials – construction-characteristics and circuits.

- *Module 2:* Resistance thermometer - temperature coefficient of resistance – RTD – material, construction and characteristic – measuring circuits – three wire and four wire method – response – thermisters – semiconductor and IC sensors.

- *Module 3*: Measurement of pressure – units of pressure – pressure standards – various types of manometers – elastic type pressure standards – various types of manometers – elastic type pressure gauges – material, construction and calibration – pressure gauges using strain gauge, capacitive, inductive and piezoelectric transducer – measurement of low presser – McLead gauge – thermal conductivity gauge – thermocouple gauges – Ionization gauges – solid state pressure transducers

- *Module 4*: Level measurement – Float activated devices – displacer devices – torque tube purge systems – diaphragm box type, manometer type – boiler drum level measurement – differential pressure method – Hydrastep method – resistance, capacitive, nucleonic and ultrasonic type level gauges – solid level measurement – gamma ray absorption method – weighing method – capacitive type – diaphragm method – rotating paddle and stack detector.

- *Module 5:* Measurement of speed – mechanical – electrical – electronic methods – stroboscopic method – measurement of acceleration – various types – calibration.

- *References*:

1. E.O.Deoblin – Measurement Systems – Applications and Design – McGraw Hill
2. C.S.Rangan,G.R.Sharma and V.S.V Mani – Instrumentation Devices and Systems – Tata McGraw Hill
3. D.P.Eckman – Industrial Instrumentation – Wiley Eastern
4. R.K.Jain – Mechanical and Industrial Instruments – Khanna Publishers.
5. D.Patranbis – Priniciples of Industrial Instrumentation – Tata McGraw Hill.

IN 503: MICROPROCESSORS AND APPLICATIONS

- *Module 1:* General organization of microprocessor based microcomputer system, internal architecture of 8085, Instruction set of 8085, Assembly language programming, examples, 8085 CPU control timing, machine cycles, Halt, wait states.

- *Module 2:* Memory system design , address and data bus structure , decoding of address bus , Memory speed requirement , data transfer between the microprocessor and peripherals ,Memory mapped I/O , I/O mapped I/O ,Device select decoding .

- *Module 3*: 8255 PPI , 8155 counter timer , serial I/O , 8251 USART , 8085 interrupt structure , 8259 programmable interrupt controller , 8257 DMA controller , 8279 key board and display controller.

- *Module 4:* Interfacing peripherals: Key board interface LED display, CRT (using 8275 CRT controller), DAC, ADC, Design of a microcomputer.

- *Module 5:* General idea about 8086, 6800 family of microprocessors 8051 microcontroller and RISC processors.

- *References*:

1. Ramesh.S.Gaonkar – Microprocesor Architecture,programming and applications.
2. S.I.Ahsen - Microprocessor with , Applications in Process Control – Tata McGraw Hill.
3. M.Rafiquzzaman – Microprocessor and Microcomputer Based System Design – Universal Book Stall , New Delhi

IN 504: ANALYTICAL INSTRUMENTS

- *Module 1:* UV – Vis –NIR spectrophotometers – Basic Principles – Laws of photometry – Radiation sources – Monochromators – Filters , Prism and Grating types – Stray light – Bandwidth and resolution detectors – Recording instruments – Scanning double beam instruments – PC based spectrophotometer.

- *Module 2*: Infrared spectrophotometers – Basic principles – Sources –IR optical systems and components – IR detectors – Data recording and analysis – Practical instruments – Fourier transform technique – FTIR principles and instrumentation – Raman spectrometry – Principles and instrumentation.

- *Module 3:* Atomic absorption spectrometry – Sources, components and instrumentation – Analysis – Plasma and plasma excitation – Thermal analysis – Principles and instrumentation of DTA, DSC and – Applications.

- *Module 4*: Magnetic resonance techniques – Nuclear magnetic resonance – Principles and Components – CW NMR spectrometer – Types of magnets and probes – Measurement techniques – Data analysis – ESR spectrometer – Principles and Instrumentation .

- *Module 5:* Mass spectrometry – Principles – Magnetic deflection mass analyzer – Electrostatic analyzer – Instrumentation and data analysis – chromatography – General principles – classification – Gas and liquid chromatography – Chromatographic detectors – GLC and HPLC – principles and instrumentation .

- *References*:

1. Willard,Merit,Dean and Settle – Instrumental Methods of Analysis – CBS
2. A.Skoog and M.West – Principles of Instrumental Analysis – Hall – Saunders International
3. G.W.Ewing – Instrumental Methods of Chemical Analysis – Mcgraw Hill

IN 505: DIGITAL INSTRUMENTS

- *Module 1*: D/A and A/D converters – D/A converters – Binary weighted and R-2R ladder type – D/A accuracy and resolution – A/D converters Counter-ramp , Successive approximation , Simultaneous , dual – slope A/D converters – A/D accuracy and resolution – Sample and hold circuit.

- *Module 2:* Frequency and time measurement – Frequency counter – Decimal counting and display – Multiplexing displays – Time base circuitry – counting input events – Frequency ratio measurement – Period measurement – Time interval and pulse width measurement – phase measurement – Scaling - Accuracy – Errors – Counting errors.

- *Module 3*: Digital voltmeters and multimeters – staircase – ramp and dual slope DVM – Successive approximation. DVM – Sources of error – Quantizing error – Automation in Voltmeters – Automatic polarity indication , ranging and zeroing – Fully automatic instrument – Digital multipliers – Current to voltage and resistance to voltage conversion - AC and RMS measurements – Q – measurement.

- *Module 4:* Other digital instruments – Digital storage oscilloscope – Principles and instrumentation – Spectrum analyzer – Digital recorders and plotters.

- *Module 5:* Microcomputer based instruments – microcomputer compatible D/A and A/D converters – Handshake input and output – Interfacing keyboard and display – Common bus and data communication standards – parallel bus standard, the HPIB or IEEE 488 – Serial bus standard – RS 232C and Modems – Interfacing CRT display – CRT character generator – CRT controllers.

- *Refernces*:

1. A.J. Bouwens – Digital Instrumentation – McGraw Hill
2. A.D. Helfrick and W.D. Cooper – Modern electronic Instrumentation and measurement techniques – Prentice Hall India
3. D.V. Hall – Microprocessors and Digital Systems – McGraw Hill.

IN 506: PRACTICALS

1. CONTROL SYSTEM LAB

Determination of T.F of an armature controlled D.C motor.
Synchronous characteristics and use as error detector.
Servo amplifier characteristics.
Transient response of second order system.
Frequency response of second order system.
Frequency response lag, lead and lag-lead network.
Study of DC and AC position control system.
Design of DC speed control system.
Study of pneumatic and hydraulic servo system.
Study of process trainer.
Characteristic of flapper value.
Simulation of position control system on analog computer.

2. TRANSDUCER LAB

Local cell characteristics
Strain gauge characteristics
RTD and thermisters characteristics
Thermocouple calibration
Hall Effect sensor
Tachometer
Capacitive sensor characteristics
Inductive sensor characteristics- LVDT
Flapper – Nozzle characteristics
LDR and optocoupler characteristics
Synchro characteristics
Vibration sensor
Elastic transducers - characteristics

SEMESTER 6

IN 601: TRANSDUCERS AND INDUSTRIAL INSTRUMENTATION – 2

- *Module 1*: Flow measurement – Bernoulli's theorem – Flow of incompressible fluids – Compressible fluids – Orifice, Nozzle, venturi, Pitot tubes – Installation and maintenance – Square root extractor – Rota meter – Installation and maintenance.

- *Module 2*: Quantity flow meters – Positive displacement – Reciprocating pistons – Oscillating pistons – Rotating disc – Helix – Oval gear – Lobed impeller type – Rotating vane – Propeller type – Turbine – Combination meter – Shunt motor – Electromagnetic type – Ultrasonic type meters – Mass flow meter – Anemometer.

- *Module 3*: Measurement of weight force, Vibration torque load cell – various types – Spring piezoelectric and strain gauge load cell – torque transducers – Various types – Cause of Vibrations – Various methods measurement – Vibration shaker – Piezoelectric and variable reluctance type – Vibration analysis of holography.

- *Module 4:* Measurement of density, viscosity specific gravity scales used in petroleum industries – Different methods of measuring consistency and viscosity – Methods for measuring moisture and humidity – Electrical conductivity – Dielectric constant – Automatic electric psycho meter.

- *Module 5*: pH and conductivity meters – pH measurement – pH electrode station – Various types of electrodes – Installation and maintenance of pH – meters – Conductivity meter – Electrical conductivity of solution – Cell construction operating principles.

- *Reference s*:

1. E.O.Deoblin – Measurement Systems Application and Designs – McGraw Hill.
2. D.Patranbis – Principles of Industrial Instrumentation – Tata McGraw Hill.
3. D.P. Eckman – Industrial Instrumentation – Wiley Eastern.
4. R.K.Jain – Mechanical and Industrial Measurement – Khanna Publishers.

IN 602: SIGNALS AND SYSTEMS

- *Module 1*: Continuous time signals: representation of continuous time signals, discrete time signals, standard test signals. General definition of a system. Examples of a system. Basic system properties.

- *Module 2:* Continuous time systems defined by an input/output differential equation- system modeling-Integrator realization. Discrete time systems defined by an input/output difference equation- Realization- convolution representation- convolution of discrete time signals- convolution of linear- time invariant continuous time systems- numerical convolutions.

- *Module 3:* Laplace transforms: properties of Laplace transforms, transfer function representation, inverse Laplace transform. Transform of input/output differential equation- transfer function of block diagrams- stability of continuous time systems- response to sinusoidal input- frequency response function- two pole systems.

- *Module 4*: Z-transform: properties, transfer function representation, inverse Z transform of rational functions- transform of input/output difference equation, stability of discrete time systems- frequency response of discrete time systems.

- *Module 5*: Fourier series representation of periodic signals- symmetry and the exponential form of the Fourier series- response to periodic inputs- Fourier transform- properties- generalized Fourier transform. Computation of output response via the Fourier transform- analysis of ideal filters- amplitude modulation- pulse amplitude modulation. Discrete time Fourier transform- discrete Fourier transform – system analysis via the DTFT and DFT.

- *References*:

1. Edward .W. Kamen – Introduction to Signals and Systems – Macmillan Publishing Company
2. Alan.V.Oppenheim and Alan.S.Willsky – Signals and System – Prentice Hall India.

IN 603: OPTOELECTRONIC INSTRUMENTATION

- *Module 1:* Interferometers – Fabry – perot and Michelson interferometers – Interference filters – Interferometeric method of measurement – Interference filters – Interferometeric method of measurement of optical components – Optical spectrum analyzer.

- *Module 2:* Modulation of Light – Birefringence – Optical activity – Electro optic effect – Kerr modulators – magneto – optic devices – Acoustic optic modulators display devices –

Luminescence – Electroluminescence – Injection Luminescence – Light emitting diode – Plasma displays – Liquid crystal displays.

- *Module 3:* Lasers – Principles of operation – Einstein relations – Population inversion – Optical feedback – laser modes – Classes of laser – Solid state, gas and liquid dye lasers – Semiconductor lasers – Q-switching and mode locking – Properties of laser light.

- *Module 4:* Application of lasers – distance measurement – Holography – Principles and applications – Industrial, biomedical and Pollution monitoring applications – Laser speckle and applications – optical fibers- light guidance through fibers- step index and graded index fibers- Multimode and single mode fibers- Fiber fabrication.

- *Module 5:* Measurement of fiber characteristics- attenuation, dispersion and refractive index profile measurement – OYDER- fiber optic components- couplers, splicers and connectors- applications of optical fibers- optical fiber communication- fiber optic sensors- measurement of temperature, pressure, displacement, acceleration, strain, fluid level, current and voltage.

- *References*:

1. J.Wilson and J.F.B.Hawkes – Optoelectronics: An Introduction – Prentice Hall of India.
2. K.Thygarajan and A.K.Ghatak – Lasers: Theory and Applications – Plenum Press
3. O.Svelto – Principles of Lasers – Plenum Press

IN 604: PROCESS CONTROL

- *Module 1:* Process dynamics- process variables- degree of freedom- characteristics of physical systems- dynamics of liquid, gas and thermal processes- interacting and non-interacting systems- continuous and batch processes. Self regulation and servo regulation operation- problems.

- *Module 2:* Control actions and controllers- basic control actions- characteristics of 2 position, multiposition, floating, proportional, I, D control modes- composite control modes- PI, PD, PID control modes, pneumatic and electronic controllers to realize various control actions.

- *Module 3:* Optimum controller settings, evaluation criteria, ¼ th decay ratio, IAE,ISE,ITAE- determination of optimum settings for mathematically described processes using time response and frequency response- tuning- process reaction curve method, continuous-cycling method, damped oscillation method.

- *Module 4:* Final control element, I/P converter, pneumatic , electric and hydraulic actuators- valve positioner, control valves, effective valve characteristics- valve body- globe, butterfly- diaphragm- ball valves- valve sizing- cavitation- flouting.

- *Module 5*: Complex control system: cascade control- feed forward control- ratio control- multivariable control. Piping and instrumentation diagram- case study- distillation column control - combustion control and drum level control in steam boiler.

- *References*:

1. Peter Harriot – Process control – Tata McGraw Hill.
2. D. Patranable – Principles of Process Control – Tata McGraw Hill.
3. Curtis Johnson – Process Control – Wiley Eastern
4. Bela. G . Liptak – Process Control , Instrument Engineer Handbook
5. Donald R Coughanowr – Process System Analysis and Control – McGraw Hill

IN 605: ENGINEERING MANAGEMENT

- *Module 1:* Principles of management – management concepts, scientific management- modern trends- management functions. Finance management: sources of finance, elements of economics- supply, demand, price, savings, consumption and investments. Costing: types- break – even analysis- profit and loss account and balance sheet, inferences.

- *Module 2:* Production and material management- plant location lay out- work place design- work study maintenance and replacement- policies- depreciation- inventory models- single order inventory policy, quality control- acceptance sampling- control charts- reliability- concept of total quality management.

- *Module 3:* Quantitative techniques- linear programming- simple assignments- routing- transportation- queuing theory, CPM and PERT- applications to management practice.

- *Module 4:* Personal management: functions-manpower- planning and inventory- recruitment- training- motivation- leadership – wage and incentive plans- industrial fatigue- accidents- safety- job evaluation- merit rating change- conflict- communication- industrial relations- disputes and trade union.

- *Module 5:* Marketing management: production design- sales strategies- sales organizations- distribution channels- marketing services- marketing research. General management: management development, organizational development- behavioral science principles.

- *References*:

1. O.P.Khanna – Industrial Engineering and Management – Dhanpat Rai and Sons
2. Paul Samuelson – Economics – McGraw Hill.
3. S.G.Huneryager and I.L.Hechman – Human Relations in Management – D.B.Tarapurvala and Sons.

4. S.Elion – Elements of Production planning and control – Macmillan Co.
5. I.M. Pandy – Financial Management – Vikas Publishing Co.
6. E.S. Baffa – Modern production management – John Wiley and Sons.
7. I.W.Burr – Engineering Statistics and Quality Control – McGraw Hill
8. A.J.Ducan – Quality control and industrial statistics – Richard.D.Irwing Inc.

IN 606: PRACTICALS

1. MICROPROCESSOR AND MICROCONTROLLER LAB

At least 15 software experiments using 8085 kit.
At least 5 experiments in 8051 microcontroller kit.
Interfacing of ADC DAC. Stepper motor, switch, LED, LVDT, thermocouple and tachometer to 8085/8051 kit.
IBM PC assembly language programming

2. INDUSTRIAL INSTRUMENTATION LAB

Orifice meter, Rota meter, venturimeter
Level measurement using different techniques
Pressure gauge calibration
EM flow meter and ultrasonic flowmeter
Measurement of pH and conductivity
Determination of viscosity coefficient
Operation of level control loop
Operation of pressure control loop
Operation of flow control loop
Test on combustion lab. Unit

SEMESTER 7

IN 701: BIOMEDICAL INSTRUMENTATION

- *Module 1:* Human anatomy and physiology- bioelectricity- resting membrane potential, action potential, transmission of impulses- electrical activity of ear, brain and muscle- ECG, EEG, and EMG wave forms. Transducers for biological applications, types, properties, characteristics and selection of transducers for biological instrumentation.

- *Module 2:* Leads and electrodes- types selection, materials, equivalent circuit of electrodes, methods of application of electrodes and leads – various functional blocks in biomedical equipment – requirement and selection- power supplies- different types of amplifiers- oscillators, modulators and demodulators- safety instrumentation- different writing systems.

- *Module 3:* Electrocardiograph- abnormal waveforms- electroencephalograph-evoked response- electromyography- conduction velocity- phonocardiography- abnormal waveforms- electroretinography- electro oculography. Blood flow meter- electromagnetic, ultrasonic and NMR.

- *Module 4:* Therapeutic instruments- cardiac pacemaker, defibrillators, hemodialysis machine- surgical diathormy equipment- physiotherapy equipment- shortwave, microwaves and ultrasonic diathermy units- stimulators- bone and muscle stimulators.

- *Module 5*: pH of blood- pH meter- respiration rate- Spiro meter- pneumotactograph- measurement of concentration of CO and O2 in exhaust air and blood- blood gas analyzer- paramagnetic oxygen analyzer- spectrophotometer- BSR and GSR- biotelemetry.

- *References*:

1. Leslie Cromwell – Biomedical Instrumentation and Measurements – Prentice Hall
2. L.A.Geddes and L.E.Baker – Principles of Applied biomedical instrumentation – John Wiley and Sons
3. B.Jacobson and J.G.Webster – Medicine and Clinical Engineering – Prentice Hall India.
4. Mackay Stuart R – Biomedical Telemetering – John Wiley
5. R.S.Khandpur – Handbook of biomedical
6. M.C.Albert and J.G.Webster – Therapeutic medical devices – Prentice Hall

IN702: PROCESSES CONTROL-02

- *Module 1*: An overview: introduction to computer control system, need for computers in a control system, functional block diagrams of computer control system .data acquisition system, supervisory control and direct digital control**.**

- *Module 2*: State variable representation in discrete System: continuous-time state variable problem-solution of the state equation –matrix exponential series approach solution of the discrete state equation –transfer function from state variable description-controllability-observability-state variable representation of composite control system.

- *Module 3*:Discrete control algorithm :mathematical modeling process i- order .i-order and i-order with pure delay ii-order pure delay, modified z-transform-pulse transfer function, analysis of discrete data system, selection of sampling time stability in z-domain, z-transform for system dead time .dead beat,Dahlin's,Kalman's and PID control algorithm.

- *Module 4*: Digital control system: distributed control system (dcs)-significance of dcs, advantages, configuration &communication facilities for dcs, programmable logic controllers –configuration, ladder diagram- interlocking systems.

- *Module 5*:Introduction to system identification &and self tuning controllers (stc)-use of artificial intelligence(AI).expert system control

- *References*:

1. Johnson – Process Control Instrumentation Technology – Prentice Hall Inc.
2. C.L.Smith – Digital computer process control – Indent Educational Publishers
3. Pradeep B.Despande and Raymond H. Ash – Elements of Computer process control with advanced control applications – Instrument Society of America, 1981.
4. C.M. Houpis and G.B. Lamont – Digital control systems – Van Nostrand Reinhold Company.
5. Michael P. Lukas – Distributed Control Systems – Van Nostrand Reinhold Company.

IN703: POWER PLANT INSTRUMENTATION

- *Module 1*:An overview :brief survey of methods power generation-hydrothermal, nuclear ,solar ,wind etc.dependance of instrumentation on the method of power generation ,power plant general structure .pulvarizers& burners nans ,dampers and actuators, super heaters, steam traps, feed water , generation turbines cooling system .importance of instrumentation and control.
  Reading and drawing of instrumentation diagram: flow sheet symbols –ANSI symbols for lines, valve, heat transfer, dryer, material handing equipment, storage vessels, flow sheet codes &lines. Graphical symbol for pipe fitting, valves and piping, instrumentation symbols, standards specifications for flow, temperature. One line diagram of typical pneumaisic, hydraulic and electrical instrumentation system.

- *Module 2*:Parameters and measurements: electrical measurements -current, voltage , power, frequency-nonlectrical parameters, flow of feed water , fuel , air&staem with correction factors for temperature pressure level, radiation detectors-smoke density measurement ,

- *Module 3*:Control loops & interlocks: combustion control- control of pressure ,air /fuel ratio , furnace draught and excess air control ,drum level (three element) control .main and reheat steam temperature control .burner tilting up , by pass damper- super heater spray &gas recirculation control -BFP recirculation control -hot well &aerator level control -interlock MFT turbine trip conditions- Pulverizer control,

- *Module 4*: Turbine monitoring& control: condenser vacuum control - gland steam exhaust pressure control -speed, vibration, shell temperature monitoring- lubricating oil temperature control. H2 generator cooling system
  Nuclear reactor control loops- description- function- safety measures in nuclear reactor control

- *Module 5*:Analysers in power plant: thermal conductive type- paramagnetic type- oxygen analyzer- infrared type and trim analyzer- spectrum analyzer- hydrogen purity meter- chromatography- ph meter- conductivity cell- fuel analyzer, pollution monitoring and control
  Computer in power plant: load dispatching computer, generation station computer, supervisory, DLC,DAS and DCC.

- *References*:

1. Modern power station practice , Volume 6, Instrumentation,Control and Testing – Pergamon Press, Oxford.
2. E.L. Wakil MM – Power Plant Technology – McGraw Hill
3. Richard Dolezal and Ludrik Varcop – Process dynamics (Automatic control of steam generation plant) - Elseiver Publishing Company Ltd.
4. J.Balasubramaniam and R.K.Jain – Modern power plant engineering – Khanna Publishers.
5. Stephen Michael Elonka and Anthony Lawrance Kohal – Standard Boiler Operations Questions and Answers – Tata McGraw Hill.
6. B.G.Liptak – Instrumentation in Processing Industries – Chiltan Book Co.
7. D.M. Considine and S.P. Ross – Handbook of Applied Instrumentation.
8. Grady C.Caracle – Industrial Instrumentation Servicing Handbook – McGraw Hill.
9. CEGB Engineers Modern Power Station Practice, Vol.6 - Pergamon

IN 704: TELEMETRY AND REMOTE CONTROL

- *Module 1*:Fundamental concepts: functional blocks of telemetry and tele control systems- methods of telemetry- electrical, pneumatic and optical telemetry, telemetry standards Landline telemetry: electrical telemetry- current- voltage- synchro and position

- *Module 2*:Radio telemetry: transmission and receiving techniques,rf modulation and d modulation- am, fm, pm, pcm, fsk,delta and adaptive modulation, multiplexing and demultiplexing- digital coding

- *Module 3*: Optical telemetry: optical fibers for signal transmission- source for fiber optic transmission - optical detectors. trend in fiber optic device development. Examples of optical telemetry systems

- *Module 4*: Analog and digital techniques in telectro, remote transmission, signaling, adjustment, guidance and regulation reliability of telectro installations. Design of telectro installation

- *Module 5*: Case study: telemetry system in process industries. satellite telemetry and telecontrol system

- *References*:

1. E.L. Gruenberg – Handbook of Telemetry and Remote control – McGraw Hill.
2. R.E. Young – Telemetry Engineering – Little Book Ltd.,J.K.
3. G. Swoboda – Telecontrol methods and applications of Telemetry and Remote control – Reinhold Publishing Company, U.K.
4. R.K. Rajangam – Industrial Telemetry – Lecture Notes, IISc. , Bangalore.

IN 705 ELECTIVE-I

(From list of electives)

IN 706: PRACTICALS

PROCESS CONTROL LAB:

Response of controllers
Integral and derivative controlled process
On -off controlled process
Proportional control process
Calibration of control valves
Closed loop air temperature control
Cascade control

IN 707: MINI PROJECT

IN 708: SEMINAR

SEMESTER 8

IN 801: VACUUM AND CRYOGENIC INSTRUMENTATION

- *Module 1*: Vacuum- basic ideas- vapors and saturated vapor pressure- gas mixtures- partial pressures- mean free path- volume flow rate- vacuum pumps- diffusion pumps- accessories – turbo molecular pumps-cryopumps.

- *Module 2:* Vacuum measurement- vacuum scale- mechanical phenomena gauges- transport phenomena gauges- ionization phenomena gauges- mounting gauge heads- calibration – accuracy.

- *Module 3:* Design considerations- conductance- gas flow regions- gas and vapor load- ultra high vacuum systems- UHV measurements- vacuum leak detection- identification of gases present.

- *Module 4*: Low temperature- basic ideas- production of low temperature- liquid nitrogen and liquid helium plants- measurement of low temperatures- storage and transfer of liquefied gases- cooling with helium-3 – the dilution refrigerator- adiabatic demagnetization.

- *Module 5:* Design of cryostats- general considerations- cryostats for specific heat, thermal conductivity and electrical resistivity measurements- cryostats for optical and x-ray studies, magnetic susceptibility measurements – closed cycle nitrogen and helium refrigerators.

- *References*:

1. N. Harris – Modern Vacuum Practice – McGraw Hill.
2. G.K.White – Experimental Techniques in low Temperature Physics – Clarendor Press
3. A.Roth – Vacuum Techniques – North Holland

IN 802: MICROCONTROLLER AND MICROCOMPUTER BASED INSTRUMENTATION

- *Module 1*: 8051 architecture:8051 microcontroller hardware-I/O pins, ports and circuits-External memory-Counter and Timers-Serial data I/O Interrupts.

- *Module 2*:8051 programming,: instruction syntax-moving data-logical operations-arithmetic operations- branching instructions.

- *Module 3*:8051 based system design: microcontroller based system design-testing the design-timing routines-look up table for the 8051- serial data transmission.

- *Module 4*:PC hardware: computer components, PC expansion architecture- design consideration of PC expansion cards. interfacing standards-General Purpose Instrumentation Bus(GPIB) – IEEE - 488 protocol-IEEE 488-2 standard-GPIB hardware-basic concepts of programming the IEEE 488 GPIB.

- *Module 5*:PC assembly language and programming: the general software environment for the PC- operating system- boot processing- system program loader- program addressing. The DEBUG program-entering and executing program. Steps in assembling ,linking and executing assembly language program. Writing COM programs- screen and key board processing in assembly language. Printing realing and writing files in assembly language.

- *References*:

1. Kenneth .J. Ayala – The 8051 Microcontroller architecture,programming and applications – Penram International Publishing.
2. Peter Norton – Inside the PC – Prentice Hall India.
3. Anhony J. Caristi – IEEE-483 General Purpose Instrumentation Bus Manual – Academic Press.
4. Peter Abel – IBM PC Assembly language and programming – Prentice Hall India.

IN 803: ELECTIVE -II

(from list of electives)

IN 804: COMPREHENSIVE VIVA-VOCE

IN 805: PROJECT

Project work.
Viva-voce.

LIST OF ELECTIVES

DIGITAL SIGNAL PROCESSING

- *Module 1*:The system function and frequency response of LTI systems- computation of frequency response function- linear time- invariant systems as frequency selective filters- design of digital filters by placement of zeros and poles in the Z plane- inverse systems.deconvolution and system identification.

- *Module 2*:Time domain sampling in continuous time signals- analog to digital conversion – digital to analog conversion- frequency domain sampling of discrete time signals- discrete Fourier transform.

- *Module 3*:Implementation of discrete time systems: structure for FIR systems- structure for IIR systems- state space system analysis and structures- representation of numbers- quantization of filter coefficients – round off effect in digital filters.

- *Module 4*:Design of digital filters- design of FIR filters, design of IIR filters from analog filters- frequency transformation – design of digital filters based on least square method.

- *Module 5*:The DFT and its properties- linear filtering methods based on the DFT- FFT algorithms- linear filtering approach to computation of DFT- quantization effect in the computation of the DFT.

- *References*:

1. John C. Proakis and Dinitris G. Manolakis – Digital signal Processing Principles,Algorithm and Applications – Prentice Hall India.
2. Alan .V. Oppenheim and Ronald .W. Schafer – Discrete time signal processing

ENVIRONMENTAL MONITORING INSTRUMENTS

- *Module 1*:Pollutants produced by human and industrial activities – need for monitoring- classification- ambient environmental monitoring- source monitoring- in plan environmental monitoring- personal monitoring.

- *Module 2*:Air pollution – different air pollutants- effects- monitoring and abatement conductivity- coulometry- electrochemical cell- piezoelectric-optical methods – instruments and case study.

- *Module 3*:Water pollution- water pollutants- health hazards. Detection techniques- emission spectroscopy- atomic absorption spectroscopy- polarography- chromatography- computer methods- waste water treatment.

- *Module 4*:Soil pollution- industrial solid pollutants- pesticides- their effect on agricultural products- salinity nutrients- residuals- monitoring- control.

- *Module 5*:Noise pollution and measurement- the effect of noise on human beings and environment – source of noise- method to measure and reduce the noise.

- *References*:

1. S.P. Mahajan – Pollution Control in Process Industries – Tata McGraw Hill.
2. J . F. Andrew,P. Briggs and S.H. Jankrins – Instrumentation for Control and Automation for water – waste water Treatment System – Pergamon Press
3. C.S. Arthur – Air Pollution – Academic Press.

NONLINEAR CONTROL SYSTEMS

- *Module 1*:Concept of control system design : basic concept of control system design, optimum design problem. Problem formulation and performance indices and state variable representation of system.

- *Module 2*:Describing function and phase plane method: definition and derivation of describing functions of nonlinear control systems- phase plane methods of constructing trajectories , phase plane analysis of linear and nonlinear control systems.

- *Module 3*:Observer: linear observer design 1 and 2 order problems.
  Stability: second method of Liapunov stability for linear and non linear systems.

- *Module 4*:Maximum principle: statement of maximum principle theory and application to minimum time, energy and control effort problem and terminal control problem.

- *Module 5*:Calculus of variations: basic minimization problem, Meyer and bolzu problem, Euler Lagrange equations, Tran versatility conditions, LaGrange multiplier, 1 orders problems as examples.

- *References*:

1. J. C. Hsu and A. U. Meyer – Modern Control Principles and Applications – McGraw Hill.
2. J. E. Gibson – Nonlinear control theory – Kogakusha Co. Ltd.
3. A .P. Sage and C .C. White – Optimum System Control – Prentice Hall of India.
4. M . Gopal – Modern Control Systems Theory – Wiley Eastern.
5. Katushiko Ogata – Modern Control systems Theory – Wiley Eastern

ADAPTIVE CONTROL AND LEARNING SYSTEMS

- *Module 1*:Mathematical model- mathematical model for processes of 1^{st} order, 2^{nd} order- 1^{st} order with pure delay- higher order systems. Discretisation techniques and computer solution of differential equations- simulation of process dynamics- introduction to adaptive control, MRAC and self tuning control.

- *Module 2*:Identification of continuous data, systems- conventional methods techniques, identification of system with dead time- smith controller, Pade approximation- multilog methods.

- *Module 3*:Identification of discrete time systems- ARMA process least squares techniques- recursive least squares – generalized recursive least squares algorithm- fixed memory algorithm.

- *Module 4*:State estimation and observers- parameter estimation and state estimation techniques- adaptive observers- extended recursive least squares FM and Kalman filter.

- *Module 5*:Adaptive control of deterministic and stochastic systems- minimum prediction – error adaptive controls- direct approach and indirect approach-adaptive algorithm for pole placement- adaptive control of time varying systems- optimal controllers.

- *References*:

1. G .C. Goodwin and K .S. Sin – Adaptive filtering , prediction and control – Prentice Hall.
2. P .Eykhoff – System Identification – John Wiley and Sons.
3. J .M. Mandel – Discrete Technique of Parameter Estimation – Marcel Dekker.
4. C .J. Harris and S .Abillings – Self Tuning and adaptive Control – Peter Peregrinus Ltd.
5. TCH Hise – System Identification – Lexington Books

PROCESS DYNAMICS

- *Module 1*:Introduction: process defined, chemical production processes , unit process and operation, conservation of mass, energy and momentum- batch and continuous processes, static and dynamic characteristics, Degrees of freedom and their importance in process control, equipment design and its constraint in automation, integral approach, formulation of mathematical model for simple processes.

- *Module 2*:Mass transfer dynamics: mass transfer process, rate equation, driving force, fugacity and concentration, Fick's law of diffusion in gas phase, equimolar counter diffusion, diffusion through stationary gas, Maxwell's law, diffusion in liquids, mass transfer in turbulent fluid, mass transfer across phase boundary transfer units.

- *Module 3*:Thermal process dynamics: basic thermal processes, physical concept, manipulation of thermal process, forced and natural convection, convection heaters, heat exchangers, two convection , convection heaters, two convectors as heaters in series, derivation of general equation for convection heat transfer, equation for liquid vapor heat exchanger, dynamic response of heat exchangers, thermal circuits.

- *Module 4*:Simultaneous heat and mass transfer: eddy transfer, quantitative relationship between heat , mass and momentum transfer, Reynolds's analogy between heat transfer and mass transfer, interaction of air and water, adiabatic humidifier, cooling towers, drying mechanism, dryers distillation, general principles, distillation columns, column dynamics.

- *Module 5*:Chemical process dynamics: chemical processes, reaction kinetics, modeling of chemical reaction systems, elements of reactor dynamics, composition regulation, recycle process.

- *References*:

1. Campbell .P. Donald – Process Dynamics – John Wiley and Sons.
2. Sherwood Thomas K. and Red Charier E – Applied Mathematics in Chemical Engineering – McGraw Hill
3. F .G. Shinskey – Process Control System – McGraw Hill

ADVANCED ANALYTICAL TECHNIQUES

- *Module 1*:x-ray method of analysis: basic principles, sources, detectors, x-ray absorption methods, x-ray fluorescence techniques, x-ray diffraction method, and electron probe microanalysis.
- *Module 2*:Electron and ion spectroscopy , x-ray and UV photoelectron spectroscopy, ESCA, electron impact spectroscopy, auger electron spectroscopy, ion scattering spectroscopy, Rutherford back scattering, principles, instrumentation and analysis.

- *Module 3*:Advanced topics in magnetic resonance spectrometry, Fourier transform techniques, nuclear quadruple resonance spectroscopy, C13 NMR, 2-d NMR, advanced topics in mass spectrometry, quadruple mass analyzer.

- *Module 4*:Electron microscopy-TEM=SEM- principles, instrumentation and analysis, scanning tunneling microscopy, atomic force microscopy, principles, instrumentation and analysis- applications.

- *Module 5*:Photoacoustic and photo thermal spectrometers, principle and instrumentation, spectroflourimeters and phosphorimetres- electrochemical instruments- conductivity meters, coulometer- amperometers, radiochemical instruments.

- *References*:

1. Willard, Merrit, Dean and Settle – Instrumental Methods of Analysis – CBS.
2. G .W. Ewing – Instrumental Methods of Chemical Analysis – McGraw Hill
3. A .Skoog and M .West – Principles of Instrumental Analysis – Hall Sanders International.
4. R .S. Khandpur – Handbook of Analytical Instruments – Tata McGraw Hill.

ADVANCED BIOMEDICAL INSTRUMENTATION

- *Module 1*:Heart-lung machine- artificial heart valves, pacemakers, and defibrillators-anesthesia machine, blood cell counters, digital thermometer, audiometer, electron microscope, up based ventilator biomaterials.

- *Module 2*:x-ray machine- radiography and fluoroscopy- image intensifiers- conventional x-ray imaging- angiography- computed tomography- linear tomography- tomography scanner- applications- magnetic resonance imaging systems- basic NMR components.

- *Module 3*:Ultrasonic imaging system- physics of ultrasonic waves, medical ultrasound, construction of an ultrasonic transducer, different modes of operations of ultrasound- A scan , B scan, echocardiograph(M mode), real time ultrasonic imaging system, computer controlled ultrasonic imaging- applications.

- *Module 4*:LASER application in machine- Pulsed Ruby LASER, nd-YAG laser, argon laser, CO2 laser, helium –neon laser, applications- advantages of laser surgery, laser based Doppler blood flow meter, endoscope, cardio scope, laproscope, endoscopic laser coagulator cryogenic surgery.

- *Module 5*: Medical thermography, physics of thermography, thermo graphic equipment, quantitative medical thermography – infrared, liquid crystal and microwave thermography- medical applications of thermography. Computer applications in medicine, computer aided ECG analysis, computerized catheterization laboratory- computerized patient monitoring system.

ROBOTICS AND EXPERT SYSTEMS

- *Module 1*:Basic concepts, power sources and sensors- definition and origin of robotics, different types of robots, degrees of freedom, Asimov's laws of robotics, dynamic stabilization of robots, determination of HP of motor and gearing ratio, variable speed arrangement, acid and nickel cadmium batteries, path determination, vision , ranging, laser, acoustics ad tactile sensors.

- *Module 2*:Manipulators, actuators and grippers- construction of manipulators, manipulator dynamics and force control, electronics and pneumatic manipulator, control circuits, pneumatic , hydraulic and electric actuators and effectors, various types of grippers, design considerations.

- *Module 3*: Kinematics- homogeneous co-ordinates, solution of inverse. Kinematics problem, multiple solutions, jacobians, work envelope.

- *Module 4*:AI and expert system- introduction, components of expert system- construction, methodology and tools for building- expert systems, characteristics of ES. Hill climbing techniques, knowledge representation, predicate calculus, resolution, robot programming languages.

- *Module 5*: Robots for production and component handling spare parts policy, payback analysis, and future in robotics.