REVISED
CURRICULUM & SYLLABUS

For

M.SC (Material Science & Technology)
Year 2011-2012

PONDICHERRY ENGINEERING COLLEGE
Affiliated to Pondicherry University
Puducherry – 605 014.

PONDICHERRY ENGINEERING COLLEGE
DEPARTMENT OF PHYSICS

M.Sc (Materials Science and Technology)
CURRICULUM AND SCHEME OF EXAMINATION

(Total number of credits required for the completion of the Programme: 72)

SEMESTER – I

Sl. No.	Code	Subject	Hours / Week			Credits	Evaluation (marks)		
			L	T	P		Internal	External	Total
1.	PH C900	Mathematical Methods for Physics	3	1	0	4	40	60	100
2.	PH C901	Classical and Statistical Mechanics	3	1	0	4	40	60	100
3.	PH C902	Materials Science- I	3	1	0	4	40	60	100
4.	-	Elective – I	3	0	0	3	40	60	100
5.	-	Elective – II	3	0	0	3	40	60	100
6.	-	Elective – III	3	0	0	3	40	60	100
7.	CE C901	Strength of Materials Laboratory	-	-	3	1	50	50	100
8.	E&I C901	Instrumentation Laboratory	-	-	3	1	50	50	100
						23	**340**	**460**	**800**

SEMESTER – II

Sl. No.	Code	Subject	Hours / Week			Credits	Evaluation (marks)		
			L	T	P		Internal	External	Total
1.	PH C903	Materials Science- II	3	1	0	4	40	60	100
2.	PH C904	Quantum Mechanics	3	1	0	4	40	60	100
3.	CS C901	Programming in C	3	0	0	3	40	60	100
4.	-	Elective – IV	3	0	0	3	40	60	100
5.	-	Elective –V	3	0	0	3	40	60	100
6.	-	Elective – VI	3	0	0	3	40	60	100
7.	PH C908	Materials Science Laboratory-I	-	-	3	2	50	50	100
8.	CS C902	Programming Laboratory	-	-	3	1	50	50	100
						23	**340**	**460**	**800**

SEMESTER – III

Sl. No.	Code	Subject	Hours / Week			Credits	Evaluation (marks)		
			L	T	P		Internal	External	Total
1.	PH C905	Nuclear and Particle Physics	3	1	0	4	40	60	100
2.	PH C906	Smart Materials and Structures	3	0	0	3	40	60	100
3.	PH C907	Electromagnetic Theory	3	0	0	3	40	60	100
4.	-	Elective – VII	3	0	0	3	40	60	100
5.	-	Elective –VIII	3	0	0	3	40	60	100
6.	PH C909	Materials Science Laboratory-II	-	-	3	2	50	50	100
7.	ME C901	Workshop Practice	-	-	3	1	50	50	100
8.	PH C910	Project Phase-I	-	-	3	2	100	-	100
						21	**400**	**400**	**800**

SEMESTER – IV

Sl. No.	Code	Subject	Hours / Week			Credits	Evaluation (marks)		
			L	T	P		Internal	External	Total
1.	PH C911	Seminar	-	-	3	2	100	-	100
2.	PH C912	Major Project	-	-	18	6	200	200	400
						8	**300**	**200**	**500**

CORE COURSES:

CODE	*SUBJECT*	*Credits*	*Hours*	*Marks*
PH C900	Mathematical Methods for Physics	4	4	100
PH C901	Classical and Statistical Mechanics	4	4	100
PH C902	Materials Science- I	4	4	100
PH C903	Materials Science- II	4	4	100
PH C904	Quantum Mechanics	4	4	100
PH C905	Nuclear and Particle Physics	4	4	100
PH C906	Smart Materials and Structures	3	3	100
PH C907	Electromagnetic Theory	3	3	100
PH C908	Materials Science Laboratory-I	1	3	100
PH C909	Materials Science Laboratory-II	1	3	100
PH C910	Project Phase – I	2	3	100
PH C911	Seminar	1	3	100
PH C912	Major Project	6	18	400
CE C901	*Strength of Materials Laboratory*	*1*	*3*	*100*
ME C901	*Workshop Practice*	*1*	*3*	*100*
CS C901	*Programming in C*	*3*	*3*	*100*
CS C902	*Programming Laboratory*	*1*	*3*	*100*
E&I C901	*Instrumentation Laboratory*	*1*	*3*	*100*

ELECTIVE COURSES:

[Credits = 3 Hours = 3 Marks = 100]

PH E901	Analytical Instrumentation
PH E902	Characterisation of Materials
PH E903	Crystal Growth and Characterisation
PH E904	High Pressure Science and Technology
PH E905	Introduction to nano technology
PH E906	Laser Spectroscopy
PH E907	Measurement and Instrumentation
PH E908	Nanomaterials: Preparation and Characterisation
PH E909	Nanoscale Fabrication and Techniques
PH E910	Non Destructive Testing
PH E911	Semiconductor Device Technology
PH E912	Sensor Technology
PH E913	Solid State Ionics
PH E914	Structure and Properties of Alloys
PH E915	Thermodynamics
CH E901	*Ceramic Materials*
CH E902	*Polymers and Composite Materials*
CE E902	*Strength of Materials*
ME E902	*Metallurgy*
ME E903	*Corrosion Science and Engineering*

PH C900 MATHEMATICAL METHODS FOR PHYSICS

Unit – I

Differential Equations and Solutions

Ordinary Differential Equations: - Series solution to second order and higher order Linear differential equations- Forbenius method – series solution to Legendre and Bessel equations, Sturm-Liouville problems, Solution of ODEs using Laplace transforms.

Unit – II

Solving algebraic and transcendental equations using matrices

Solution of general system of Linear equations by Gauss elimination, Cramer's rule, Gauss-Jordan elimination - Inverse of a matrix by row transformation-cayley-Hamilton theorem- Matrix eigenvalue problems.

Unit – III

Vector Calculus

Vector Calculus: Vector analysis - Vector and scalar functions and fields - Derivatives, Gradient, Divergence and Curl (their properties and relations) - Vector integral calculus - Line integrals, Surface integrals, Green's theorem, Gauss theorem - Applications, Stoke's theorem.

Unit – IV

Fourier Analysis and partial differential equations

Fourier analysis and Partial differential equations: Fourier series, Fourier integrals, Fourier transforms; Partial differential equations - Solution of Wave equation by Separation of variables, Fourier series solution of Heat flow equation.

Unit – V

Theory of Complex Variables

Complex Analysis: Complex numbers and functions, Complex integration- Cauchy's theorem, Cauchy-Reimann equation. Power series, Taylor series, Maclaurin series, Laurent series, Singularities and zeros, Residue integration, Complex analysis applied to potential theory.

Text Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics. 8th ed. John Wiley & Sons, Inc., 1999 (Chapters 1—16).
2. Herbert Kreyszig & Erwin Kreyszig, Students Solution manual - Advanced Engineering, Mathematics 8th ed. John Wiley & Sons, Inc., 2001.
3. Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 1998.
4. Gupta, B.D., Mathematical Physics 3rd Edition, Vikas Publishing House Pvt Ltd, 2004

Reference Books:

1. Merle C. Potter & Jack Goldberg, Mathematical Methods. 2nd ed. Prentice Hall of India Pvt Ltd, 1998.
2. K. F. Riley, M. P. Hobson & S. J. Bence, Mathematical Methods for Physics and Engineering. Low Price ed. Cambridge University Press, 1999.
3. George B. Thomas & Ross L. Finney, Calculus and Anaytic Geometry. 9th ed. (low price) Pearson Education, Inc., 1996.
4. Sadri Hassani, Mathematical Physics - A Modern Introduction to Its Foundations. Springer-Verlag New York, Inc., 1999.
5. Ray C. Wiley & Louis C. Barret, Advanced Engineering Mathematics. 6th ed. Tata McGraw-Hill 2003.
6. R. K. Jain & S. R. K. Iyengar, Advanced Engineering Mathematics. 2nd ed. Narosa Publishing House, 2003.
7. Schaum's outline series; McGraw-Hill Differential Equations, Laplace Transforms, Matrix Operations, Linear Algebra, Fourier Analysis, Partial Differential Equations, Complex Variables, Mathematical Handbook

PH C901 CLASSICAL AND STATISTICAL MECHANICS

UNIT- I:

Lagrangian and Hamiltonian formulation

Constraints and their classification, Lagrange's equations of motion of first kind, D'Alembert's principle, generalized coordinates- potentials- momenta and energy, derivation of Lagrange's equations of motion of 2nd kind from D'Alembert's principle, cyclic coordinates and integrals of motion, homogeneity of time and conservation of energy, homogeneity of space and conservation of momentum, Isotropy of space and conservation of angular momentum, derivation of Hamilton's equations of motion using Legendre's dual transformation, configuration space, phase space and state space, principle of least action and Hamilton's principle, derivation of Euler-Lagrange equations of motion from Hamilton's principle.

UNIT- II:

Central force, scattering theory & Canonical transformation

Inertial forces in the rotating frame, non inertial frames-pseudo forces and Coriolis force, central force: definition and properties, two-body central force problem, center-of-mass and laboratory coordinate systems, collision and scattering: scattering cross section, scattering by a central force: Rutherford formula, canonical transformations: definition-properties and examples, Poisson's bracket: definition and properties, invariance of Poisson bracket under canonical transformation.

UNIT- III:

Rigid body dynamics and Small oscillations

Derivation of kinetic energy and angular momentum of a rotating rigid body, moment of inertia tensor, transformation of inertia tensor, principal moment of inertia and ellipsoid of inertia, calculation of moment of inertia, Eulerian rotation and Euler angles, Euler's equation of motion for rigid bodies, small oscillations: Types of equilibrium, equations of motion of a coupled system and normal modes.

UNIV - IV:

Classical Statistics

Fundamental concepts of phase space, microstate and ensemble, postulates of classical statistical mechanics, relation between entropy and probability, microcanonical ensemble (MCE), derivation of thermodynamics from MCE, the equipartition theorem (without proof). derivation of classical ideal gas equation using MCE, Gibb's paradox-Sackur-Tetrode equation, Canonical ensemble-introduction and energy fluctuation, partition function for canonical ensemble, calculation of thermodynamic quantities from partition function, derivation of classical ideal gas equation using canonical ensemble.

UNIT - V:

Quantum Statistics

Introduction to quantum statistics, Maxwell-Boltzmann (MB) statistics-derivation of distribution function, Bose-Einstein (BE) statistics-derivation of distribution function, Fermi-Dirac (FD) statistics-derivation of distribution function, photon statistics and derivation of Plank's distribution law, derivation of Fermi energy of a degenerate Fermi gas, Bose-Einstein condensation, first and second order phase transitions, critical point.

Text/ References:

1. N. C. Rana and P. S. Joag. Classical Mechanics. Tata McGraw Hill Publishing Company Limited, New Delhi, 1991.
2. H.Goldstein, Classical mechanics, Narosa Publising House, New Delhi, 1989
3. Federick Reif. Fundamentals of Statistical and Thermal Physics (Chapter 9), McGraw Hill, 1985.
4. Kerson Huang. Statistical Mechanics (Chapters 6, 7), John Wiley & Sons, 2nd edition, 1987.
5. M.C.Gupta, Statistical Thermodynamics, Wiley Eastern Ltd., New Delhi, 1993

PH C902 MATERIALS SCIENCE - I

UNIT I

Crystal structures

Space group symmetry – Symmetry operations – Point group and Space group symmetry – Crystal structures – chemical binding in solids – Close packed structures – Radius ratio rules – Miller indices – Reciprocal lattice – X-ray diffraction – Atomic scattering factor and structure factor (with out rigorous derivation) – interpretation of X-ray diffraction data to determine simple crystal structures – X-ray diffraction experimental methods to determine crystal structure – Laue, rotating single crystal and powder methods – electron and neutron diffraction – X-ray diffraction by Amorphous materials.

Unit II

Electrical Properties of Metals

Classical free electron theory of metals – Drawbacks of Classical theory – Quantum free electron theory – Fermi Dirac Statistic and Electron distribution in solids – Density of energy states and Fermi energy – The Fermi Distribution function – Heat capacity of electron gas – Electron scattering and Sources of Resistance in metals – Electron-scattering mechanisms and Variation of Resistivity with Temperature – Thermal Conductivity in metals.

Unit III

Thermal Properties

Theories of specific heats – Einstein's and Debye's theories – Lattice vibration in one dimensional – mono atomic and diatomic lattices – Phonons – Thermal Conductivity – umklapp process – Thermal expansion – Interaction of phonons with electron, photon, and phonon (qualitative ideas) –(Phonon Scattering by neutron diffraction) – Thin films – Preparation and properties.

Unit IV

Band Theory of Solids

Formation of Bonds in Solids – Band theory of Solids – Kronig Penney model _ Brillion Zones – motion of electrons in one dimensional periodic potential – Effective mass of electrons – concept of Holes – classification of materials according to Band theory – Fermi Surfaces in metals – Band structure of Semi conductors

Unit V

Semiconductors

Intrinsic Semiconductors – Conductivity and Temperature – Statistics of Electrons and Holes in Intrinsic Semiconductors – Electrical conductivity – Impurity Semiconductors or Extrinsic Semiconductors – Statistics of Extrinsic Semiconductors – Mechanism of current Conduction in semiconductors – mobility of Current carriers - Hall effect – Advantages of Semiconductor Devices – The p-n Junction – Some Special p-n junction Diodes.

Text Books:

1. Solid State Physics, A.J. Dekkar, Mac Millan Student Ed. , 1986.
2. Introduction to Solid State Physics, S.O.Pillai,Wiley Eastern & Sons – 2005.
3. Introductory Solid State Physics, H.P. Mayers, Viva Book Publishers, New Delhi- 1998.
4. Electronic Engineering Materials and Devices, J. Allison, Tata Mc Graw Hill, 1985.
5. Solid State Physics, J.S. Blackmore, Cambridge University Press, 1985.
6. M.Ali Omar, Elementary Solid State Physics, revised printing Pearson Education (2000)

Reference Books:

1. Principles of Solid State Physics, H.V. Keer, Wiley Eastern, 1993.
2. Materials Science, J.C. Anderson & KDB Lever, ELBS fifth Edn., 2004.
3. Modern Materials Science, J. Granct, Printice Hall, 1980.
4. Electrical Engineering Materials, A. J. Dekker, Prentice Hall, 1983.
5. Physical Properties of Materials, M.C. Lovell etal, ELBS, 1984.
6. Physics of Magnetic Semiconductors, E.L. Nagaer, Mir Publishers, 1983.
7. Super conductivity, Mical. Cesnot, World University, Classic, 1992.
8. Harald Ibach and Hans Lueth, Solid State Physics, 2nd edition Springer (1996)
9. N.W. Ashcroft and N.D. Mermin Solid State Physics, Thomson Brrooks/Cole (1976)

PH C903 MATERIALS SCIENCE - II

Unit I

Dielectric polarization:

Mechanism of polarization – electronic, ionic and orientational polarization – Lorentz Internal field - Clausius- Mossatti relation – Temperature dependence of static permitivity – Complex permitivity – dielectric loss – frequency dependence of polarization – Experimental determination of dielectric constant and dielectric loss by Scherring Bridge method Piezo and Pyro electricity- materials and applications– Ferroelectricity – dipole theory of ferroelectrics – ferro electric materials and applications.

Unit II

Optical properties:

optical constants – absorption of radiation in metals, semiconductors and insulators – edge absorption and excitons (elementary ideas) – Luminescence – Phosphorescence and fluorescence – photoluminescence in semiconductors and insulators – photoconductive devices – solar cells – electroluminescence – LED – Thermoluminescence, Cathodoluminescence- Luminescent materials – ZnS phosphors, Thallium activated alkali halides, lamp phosphors

Unit III

Magnetic properties:

Classification of magnetic materials- Dia, Para , Ferro, antiferro and ferrimagnetic materials – domain theory and hysteresis – Weiss molecular field theory and Curie –Weiss law – Quantum mechanical theory for ferromagnetism- Outline of Heisenberg's exchange theory – magnetic anisotropy – Domain walls and Domain theory – Antiferro magnetism- Two sub lattice model- Ferri magnetism – soft and hard magnetic materials , and their applications- metals, alloys and ceramic materials – application of magnetic materials in data storage – magnetic bubble domains.

Unit IV

Superconductivity-I :

Superconductivity – Transition temperature Tc – Critical field Hc- Isotope, pressure, magnetic field effects on Tc – Meissner effect – type I and type II super conductors – London equation – thermodynamics of superconductors – free energy – entropy – specific heat – BCS theory – Superconducting energy gap – DC and AC Josephson effects – Quantisation of flux – Quantum interference.

Unit V

Superconductivity II:

High temperature superconductors – copper free oxide superconductors – preparation of Cuprates – Modern theories of HTSc – Qualitative ideas of RVB theory – application of superconductors – High field magnets, motors, generators – Magnetic Levitation and transportation – Nuclear magnetic resonance imaging – energy storage – superconducting power transmission - devises based on Josephson's effect – SQUID – memory elements – Signal Processing.

Text Books:

1. Introduction to Solid State Physics, S.O.Pillai, New Age International (2005)
2. V.Raghavan, Materials Science and Engineering, Prentice Hall,2003.
3. D.R.Tilley and J.Tilley, Superfludity and superconductivity, 3rd Edition, Hilger,1990.
4. Charles Kittel, Introduction to solid state physics, Wiley 7th edition, 1996.
5. H.V.Keer, Principles of solid state physics, Wiley - Eastern, 1993.

Reference Books:

1. Principles of Solid State Physics, H.V. Keer, Wiley Eastern, 1993.
2. Materials Science, J.C. Anderson & KDB Lever, ELBS fifth Edn., 2004.
3. Physics of Magnetic Semiconductors, E.L. Nagaer, Mir Publishers, 1983.
4. Super conductivity, Mical. Cesnot, World University, Classic, 1992.
5. Electronic Engineering Materials and Devices, J. Allison, Tata Mc Graw Hill, 1985.
6. Solid State Physics, Ashcroft & Mermin, Thomson Asia, Singapore, (2003)
7. Fundamentals of Solid State Physics, J. Richard Christman, John Wiley& Sons, (1988)

PH C904 QUANTUM MECHANICS

Unit-I

Postulates of quantum mechanics-operator formalism-commutation relations-expectation values. Solution of Schroedinger's wave equation-three dimensional linear harmonic oscillator, one dimensional square well potential, Tunneling through a one dimensional potential barrier.

Unit-II

Matrix representation of quantum mechanics- application to one dimensional Simple harmonic Oscillator. Angular momentum- commutation relations-Eigen values and eigen functions of angular momentum - Ladder operator method – Matrix representation of angular momentum operators-combination of two angular momenta, Clebsch Gordon Coefficients. Hydrogen atom –solution of Schroedinger's wave equation for eigen values and eigen functions.

Unit-III

Time independent perturbation theory for non-degenerate and degenerate levels- application to one dimensional anharmonic oscillator, First Order Stark effect in hydrogen, Zeeman effect. Variation method- ground state energy of Helium atom, Heitler-London theory for Hydrogen molecule.

Unit-IV

First order time dependent perturbation theory – Transition probabilities – Fermi's Golden rule- Harmonic perturbation-interaction of electromagnetic radiation with matter, Einstein's coefficients- selection rules for harmonic oscillator and hydrogen atom (without rigorous derivations), Scattering Theory: Scattering cross section –Born's approximation, scattering by an attractive square well potential

Unit-V

Partial wave analysis-phase shifts-low energy scattering – scattering by an attractive square well potential. Identical particles and spin. Relativistic quantum mechanics –Klein Gordan equation-Pauli's Spin matrices and Dirac matrices.

Text Book

1. Quantum Mechanics, G. Aruldhas, Prentice Hall India, (2002)

Reference Books

1. A Text Book of Quantum Mechanics , P.M. Mathews and K. Venkatesan,Tata McGraw Hill Publishing Co., New Delhi (1985)
2. Quantum Mechanics , 4th Edn, Ajoy Ghatak and S. Lokanathan, MacMillan(1999)
3. Elements of Quantum Mechanics, Michael D. Fayer, (2001)
4. Quantum Mechanics L.I. Schiff, McGraw Hill, (1996)
5. Quantum Mechanics, L.M. Pauling and H. Wilson , McGraw Hill, (1935)
6. Introduction to quantum Mechanics, Dicke and Wittke, Addison Wesley (1963)
7. Introduction to Quantum Mechanics, Ajoy Ghatak, MacMillan India, (1996)
8. Quantum Mechanics, 7th Edn., S.L.Gupta, V. Kumar,H.V. Sharma and R.C. Sharma, Jai Prakash Natt & Co, Meerut, (1987)
9. Quantum Mechanics, L. Powell and Crasemann, Narosa Publishing House, (1988)

PH C905 NUCLEAR and PARTICLE PHYSICS

UNIT I

Basic Nuclear Properties and models:

Size, shape, Nuclear radii, Charge distribution, spin and parity, electric and magnetic moment, Binding energy, Weizacker semi-empirical formula, evidence of shell structure, single-particle shell model, its validity and limitations-liquid drop model-Fermi gas model.

UNIT II

Nuclear forces and Nuclear disintegration:

Classification of fundamental forces- nature of nuclear force, form of nucleon-nucleon potential, charge independence and charge symmetry of nuclear forces, isospin, non central forces and exchange forces- elementary ideas of α, β and γ-decays, Gamow's theory - Fermi theory, selection rules, Nuclear isomerism, ground state of deuteron - n-p scattering-p-p scattering - Partial wave analysis.

UNIT III

Nuclear reactions**:**

Types of nuclear reactions, -reaction mechanism- compound nuclei and direct reactions –yield and nuclear reaction – Breit – Wigner formula –thermonuclear reaction- hydrogen fusion reactions- Neutron Diffusion theory – Neutron leakage – diffusion and slowing down length- Slowing down of neutrons, Fermiage theory – microscopic and macroscopic cross section.

UNIT IV

Nuclear Fission, Reactors and Reactors Materials:

Nuclear fission, fission energy- fission cross section, fission neutrons, chain reaction, multiplication factors- four factor formula- Classification of nuclear reactors – PWR, BWR, BHWR, FBTR-reactor materials (fuel, moderators, coolant and control materials).

UNIT V

Elementary Particles:

Quarks, baryons, mesons and leptons, quark model, spin and parity assignments- strangeness- Gellman Nishijima formula - quantum chromo dynamics (QCD), C, P, and T invariance (NCP & CPT invariance) and application & symmetry arguments to particle reactions, symmetry,- unitary symmetry SU(2) – SU(3) - parity non-conversation in weak interaction-relativistic kinematics.

Text/ Reference Books:

1. Introductory Nuclear Physics, Samuel S. M. Wong (2nd edition) willey –Interscience (1999).
2. Introductory Nuclear theory, L.R.B.Elton, pitman & son (1970)
3. Nuclear Physics, Irwing Kaplan ,Narosa book distributors (2002) 2nd Edition
4. Introduction to Elementary Partical Physics, Alessandro Bettini Cambridg University (2008).
5. Introduction to elementary particles 2nded. Wiley –VCH, Germany (2008).

PH C906 SMART MATERIALS and STRUCTURES

UINT I

Introduction And Historical Perspective

Classes of materials and their usage – Intelligent /Smart materials – Evaluation of materials Science – Structural material – Functional materials – Polyfunctional materials – Generation of smart materials – Diverse areas of intelligent materials – Primitive functions of intelligent materials – Intelligent inherent in materials – Examples of intelligent materials, structural materials, Electrical materials, bio-compatible materials etc. – Intelligent biological materials – Biomimetics – Wolff's law – Technological applications of Intelligent materials.

UNIT II

Smart Materials And Structural Systems

The principal ingredients of smart materials – Thermal materials – Sensing technologies – Micro sensors – Intelligent systems – Hybrid smart materials – An algorithm for synthesizing a smart material – Passive sensory smart structures– Reactive actuator based smart structures – Active sensing and reactive smart structures – Smart skins – Aero elastic tailoring of airfoils – Synthesis of future smart systems.

UNIT III

Electro-Rheological (Fluids) Smart Materials

Suspensions and electro-rheological fluids – Bingham-body model – Newtonian viscosity and non-Newtonian viscosity – Principal characteristics of electro rheological fluids – The electro-rheological phenomenon – Charge migration mechanism for the dispersed phase – Electro-rheological fluid domain – Electrorheological fluid actuators – Electro-rheological fluid design parameter – Applications of Electrorheolgoical fluids.

UNIT IV

Piezoelectric Smart Materials

Background – Electrostriction – Pyroelectricity – Piezoelectricity – Industrial piezoelectric materials – PZT – PVDF – PVDF film – Properties of commercial piezoelectric materials – Properties of piezoelectric film (explanation) – Smart materials featuring piezoelectric elements – smart composite laminate with embedded piezoelectric actuators – SAW filters.

UNIT V

Shape – Memory (Alloys) Smart Materials

Background on shape – memory alloys (SMA) Nickel – Titanium alloy (Nitinol) – Materials characteristics of Nitinol – Martensitic transformations – Austenitic transformations – Thermoelastic martensitic transformations – Cu based SMA, chiral materials – Applications of SMA – Continuum applications of SMA fastners – SMA fibers – reaction vessels, nuclear reactors, chemical plants, etc. – Micro robot actuated by SMA – SMA memorisation process (Satellite antenna applications) SMA blood clot filter – Impediments to applications of SMA – SMA plastics – primary molding – secondary molding – Potential applications of SMA plastics.

Text/ References:

1. M.V.Gandhi and B.S. Thompson, Smart Materials and Structures Chapman and Hall, London, First Edition, 1992
2. T.W. Deurig, K.N.Melton, D.Stockel and C.M.Wayman, Engineering aspects of Shape Memory alloys, Butterworth – Heinemann, 1990
3. C.A.Rogers, Smart Materials, Structures and Mathematical issues, Technomic Publising Co., USA, 1989.

PH C907 ELECTROMAGNETIC THEORY

UNIT-I:

Electrostatics

The electric field – divergence and curl of electrostatic fields, Electric potential – Poisson's and Laplace's equations, Work and Energy in electrostatics, Conductors, Electric fields in matter – Polarization, the field of a Polarized object, the electric displacement, linear dielectrics.

UNIT-II:

Boundary value problems & Special techniques

Laplace's equation in one, two and three dimensions, uniqueness theorems (without proof), the method of images, separation of variables – Cartesian and spherical coordinates, Multipole expansion, the electric field of a dipole.

UNIT-III:

Magnetostatics

The Lorentz force law and the Biot-Savart law, The divergence and curl of B , Magnetic vector potential, Magnetic fields in matter - Magnetization, the field of a magnetized object – bound currents and physical interpretation, Ampère's law in magnetized materials and the auxiliary field H , linear and nonlinear media – magnetic susceptibility and permeability.

UNIT-IV:

Electrodynamics

Electromotive force, Electromagnetic induction, Maxwell's equations, The continuity equation, Pounting's theorem (without proof), Electromagnetic waves in vacuum – the wave equation for E and B , Energy and momentum in electromagnetic waves

UNIT-V:

Potentials and Radiation

Potential formulation, Gauge transformations, Coulomb and Lorentz gauge, retarded potentials of continuous charge distribution, retarded potentials of point charges, Li´enard-Wiechert potential, electric dipole radiation.

Text Book:

1. Griffiths D J (1999). Introduction to electrodynamics. Prentice Hall of India Private Limited, New Delhi, 3rd edn. (Chapters 2 – 7, selected topics from chapters 8, 9, 10 11.)

Text/ References:

1. E.F,Jordan and K.G.Belmain, Electromagnetic waves and Radiating Systems - Prentice-Hall of India Pvt. Ltd., New Delhi, 1982.
2. D.R.Corson and Paul Lorrain, Introduction to Electromagnetic fields and waves, D.B. Taraporevale Sons & Co. Pvt. Ltd., Bombay, 1970.

PH E901 ANALYTICAL INSTRUMENTATION

UNIT I

Basic concepts of Absorption and emission spectroscopy – representation of spectra – basic elements of practical spectroscopy – signal to noise ratio - hardware and software techniques for signal to noise enhancement – resolving power – Fourier transform spectroscopy – evaluation of results – basic principles, instrumentation and applications of atomic absorption, atomic fluorescence and atomic emission spectroscopy – ICP atomic fluorescence spectroscopy.

UNIT II

Infrared spectroscopy – correlation of IR Spectra with molecular structure, instrumentation, samplings technique and quantitative analysis. Raman Spectroscopy – Classical and Quantum theory instrumentation, Structural analysis and quantitative analysis.

Nuclear magnetic resonance spectroscopy – pulsed Fourier transform NMR spectrometer – elucidation of NMR spectra and quantitative analysis : Electron Spin Resonance Spectroscopy –

UNIT III

Surface study – x-ray emission spectroscopy (XES), electron spectroscopy for chemical analysis (ESCA) - UV photo electron spectroscopy (UPS) - X- ray photo electron spectroscopy (XPS) - Auger emission Spectroscopy (AES) - Transmission Electron microscopy (TEM) - Scanning Electron microscopy (SEM), Surface tunneling microscopy (STEM) - Atomic force microscopy (AFM).

UNIT IV

Mass spectroscopy – Ionization methods in mass spectroscopy – mass analyzer – ion collection systems, correlation of molecular spectra with molecular structure. Instrumentation design and application of Fourier transform mass spectroscopy (FT-MS). Inductively coupled plasma mass spectroscopy (ICP-MS), Secondary Ion Mass Spectroscopy (SIMS) and Ion microprobe mass analyzer (IMMA).

Radio chemical methods – Activation analysis, isotope dilution analysis. Liquid scintillation system. Application of Radionuclides.

UNIT V

Thermal analysis: principles and instrumentations of thermogravimetry (TG), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), evolved gas detection, thermo mechanical analysis, dynamic mechanical analysis, Thermometric titrimetry and direct – injection enthalpimetry.

Text Books:

1. Instrumental methods of Analysis, Willard, Merritt, Dean and Settle, CBS Publishers and distributors, New Delhi, 7th edition, 1986.
2. Fundamentals of Molecular Spectroscopy, C.N Banwell and E.M. Mc Cash, Tata Mc Graw Hill, New Delhi, 1994.
3. Electron Beam Analysis of Materials, M.H. Loretto, Chapman and Hall, 1984.
4. Introduction to Mass Spectrometry, J.T. Watson, Raven, New York 1985.
5. Thermal Methods of Analysis, W. Wendlandt, John Wiley, New York, 1986.

Reference Books:

1. Surface Physics, m. Prutton, Clarenden press, Oxford, 1975.
2. Transmission Electron Microscopy of Materials, G. Thomas, J.G. Michael, John Wiley and Sons, 1979.
3. Instrumental methods in Chemical Analysis, Wing GW, Mc Graw Hill, 1975.

PH E902 CHARACTERISATON OF MATERIALS

UNIT I

THERMAL ANALYSIS

Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)- cooling curves - differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters .

UNIT II

MICROSCOPIC METHODS

Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy - phase contrast microscopy -differential interference contrast microscopy - fluorescence microscopy - confocal microscopy - scanning probe microscopy (STM, AFM) - scanning new field optical microscopy - digital holographic microscopy - oil immersion objectives - quantitative metallography - image analyzer.

UNIT III

ELECTRON MICROSCOPY AND OPTICAL CHARACTERISATION

SEM, EDAX, EPMA, TEM: working principle and Instrumentation – sample preparation – data collection, processing and analysis- Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.

UNIT IV

ELECTRICAL METHODS

Two probe and four probe methods- van der Pauw method – Hall probe and measurement – scattering mechanism – C-V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C-V profiling – limitations.

UNIT V

SPECTROSCOPY

Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR, NQR, XPS, AES and SIMS-proton induced X-ray Emission spectroscopy (PIXE) –Rutherford Back Scattering (RBS) analysis-application.

Text/ References:

1. Stradling, R.A; Klipstain, P.C; Growth and Characterization of semiconductors, Adam Hilger, Bristol,1990.
2. Belk, J.A; Electron microscopy and microanalysis of crystalline materials, Applied Science Publishers, London, 1979.
3. Lawrence E.Murr, Electron and Ion microscopy and Microanalysis principles and Applications, Marcel Dekker Inc., New York, 1991
4. D.Kealey & P.J.Haines, Analytical Chemistry, Viva Books Private Limited, New Delhi 2002.
5. Instrumental methods of Analysis, Willard, Merritt, Dean and Settle, CBS Publishers and distributors, New Delhi, 7th edition, 1986.

PH E903 CRYSTAL GROWTH AND CHARACTERISATION

Unit I:

Materials Purification:

Distillation, Sublimation, Precipitation – liquid – liquid extraction, ion exchange, gas and liquid chromatography and Zone melting.

Unit II:

Growth of Single Crystals:

Classification of growth processes, equilibria in Crystal growth – mono component solid state equlibria. The distribution coefficient phase diagrams, conservative and non conservative processes. Constitutional supercooling.

Unit III:

Growth Kinetics:

Driving force, crystal morphology, possible types of interfaces. Nucleation – critical size of homogeneous and heterogeneous nuclei, rate of homogeneous nucleation, growth of solid – atomic mechanism, growth rate on diffuse interface and faceted interface.

Unit IV:

Growth Technique:

Solid state equilibria: Strain and annealing, Sintering and polymorphic transition – Solid State Equilibria : Bridgmann-Stockbarger technique, Czochralski and Kyropolous – Zone melting and other crucible less techniques. Dendrite growth. – Vapour Solid Equilibria: Sublimation – condensation, sputtering, growth by irreversible reactions – Growth from solution: aqueous-solution growth, Hydro-thermal growth and molten salt growth – Gel growth.

Unit V:

Crystal Characterization**:**

Review of crystal systems – orientations and planes. Orientation of crystals by optical and x-ray methods. Crystal cutting and polishing. Observation of defects in crystals (optical microscopy). Thermal , optical and mechanical properties of crystals (qualitative study).

Text Books:

1. Physical and Chemical Methods of Separation, Eugence W. Berg, Mc Graw Hill Co., 1963.
2. Methods of Experimental Physics, Marton L., (ed) Vol. 64, Academic Press 1959.
3. The Growth of Single Crystals, Laudise, R.A., Prentice Hall, 1970.
4. Phase Transformations in Meterials, Jain, A.K. and Chaturvedi, Prentice Hall, 1972.
5. The Growth of Single Crystals from Liquids, J.C. Brice, North Holland, 1973.
6. Crystal Technology, W.L. Bond, John Wiley & Sons, New York, 1976.

Reference Books:

1. Instrumental Methods in Chemical Analysis, G.W. Wing, McGraw Hill Co., 1975.
2. Crystal Growth and Characteristation, R. Veda and J.B. Mullin (ed), North Hill, 1975.

PH E904 HIGH PRESSURE SCIENCE and TECHNOLOGY

UNIT I

METHODS OF PRODUCING HIGH PRESSURE

Definition of pressure – Hydrostaticity – generation of static pressure, pressure units – piston cylinder – Bridgmann Anvil – Multi-anvil devices – Diamond anvil cell.

UNIT II

MEASUREMENT OF HIGH PRESSURE

Primary gauge – Secondary gauge – Merits and demerits – Thermocouple pressure gauge – Resistance gauge – fixed point pressure scale – Ruby fluorescence – Equation of state.

UNIT III

HIGH PRESSURE DEVICES FOR VARIOUS APPLICATIONS

X-Ray diffraction, Neutron diffraction – Optical studies – Electrical studies – Magnetic studies – High and low temperature applications – Ultra high pressure anvil devices.

UNIT IV

HIGH PRESSURE PHYSICAL PROPERTIES

PVT Relation in fluids – Compressibilities of solids – properties of gases under pressure - Melting phenomena – viscosity – thermo emf – thermal conductivity. Electrical conductivity – phase transitions phonons superconductivity – Electronic structure of metals and semiconductors – NMR and magnetic properties. Liquid crystals – spectroscopy studies –Infrared, Raman Optical absorption – EXAFS.

UNIT V

MECHANICAL PROPERTIES UNDER PRESSURE

Elastic constants – Measurements – mechanical properties – Tension and compression – Fatigue – Creep – Hydrostatic extrusion. Material synthesis – Superhard materials – Diamond – Oxides and other compounds – water jet.

Text Books:

1. The Physics of High Pressure, P.W. Bridgemann, G.Bell and Sons Ltd, London 1931.
2. High Pressure Science and Technology, Vol. I&II, B. Vodar and Ph. Marteam, Pergamom Press, Oxford, 1980.
3. Mechanical Behaviour of Materials under Pressure, H. L.D. Pugh, Elsevier Pub. Co. Ltd., New York 1970.
4. Solid State Physics, Vol. 13, 17 and 19, Frederick and Turnbull, Academic Press, New York, 1962.
5. M.I. Eremets, High-pressure Experimental methods, New York, 1996.

PH E905 INTRODUCTION TO NANOSCIENCE and TECHNOLOGY

UNIT I

NANOSCALE SYSTEMS:

Length, energy, and time scales - Quantum confinement of electrons in semiconductor nanostructures: Quantum confinement in 3D, 2D, 1D and zero dimensional structures -Size effect and properties of nanostructures- Landauer-Buttiker formalism for conduction in confined geometries - Top down and Bottom up approach.

UNIT II

QUANTUM DOTS:

Excitons and excitonic Bohr radius – difference between nanoparticles and quantum dots - Preparation through colloidal methods - Epitaxial methods- MOCVD and MBE growth of quantum dots - current-voltage characteristics - magneto tunneling measurements - spectroscopy of Quantum Dots: Absorption and emission spectra - photo luminescence spectrum - optical spectroscopy - linear and nonlinear optical spectroscopy.

UNIT III

SYNTHESIS OF NANOSTRUCTURE MATERIALS:

Gas phase condensation – Vacuum deposition -Physical vapor deposition (PVD) - chemical vapor deposition (CVD) – laser ablation- Sol-Gel- Ball milling –Electro deposition- electroless deposition – spray pyrolysis – plasma based synthesis process (PSP) - hydrothermal synthesis

UNIT IV

CHARACTERIZATION:

Principle and working of Atomic Force Microscopy (AFM) and Scanning tunneling microscopy (STM) - near-field Scanning Optical Microscopy – Principle of Transmission Electron Microscopy (TEM) – applications to nanostructures – nanomechanical characterization – nanoindentation

UNIT V

NANOTECHNOLOGY APPLICATIONS**:**

Applications of nanoparticles, quantum dots, nanotubes and nanowires for nanodevice fabrication – Single electron transistors, coulomb blockade effects in ultra-small metallic tunnel junctions - nanoparticles based solar cells and quantum dots based white LEDs – CNT based transistors – principle of dip pen lithography.

Text/ References:

1. “Nanotechnology” G. Timp. Editor, AIP press, Springer-Verlag, New York, 1999
2. “Nanostructured materials and nanotechnology’’, Concise Edition, Editor:- Hari Singh Nalwa; Academic Press, USA (2002).
3. “Hand book of Nanostructured Materials and Technology’’, Vol.1-5, Editor:- Hari Singh Nalwa; Academic Press, USA (2000).
4. “Hand book of Nanoscience, Engineering and Technology (The Electrical Engineering handbook series), Kluwer Publishers, 2002
5. “Sol-Gel Science”, C.J. Brinker and G.W. Scherrer, Academic Press, Boston (1994).
6. Nanoscale characterization of surfaces & interfaces, N John Dinardo, Weinheim Cambridge: Wiley-VCH, 2nd ed., 2000.

PH E906 LASER SPECTROSCOPY

Unit I

Laser as light source, fundamentals of laser- laser resonators, spectral characteristics of laser emission, single-Mode lasers, wavelength tuning of single-Mode lasers- line width. Nonlinear optics: Harmonic generation, second and third harmonic generation, frequency mixing ,-phase conjugation.

Unit II

Laser Raman spectroscopy – basic experimental techniques, non-linear Raman spectroscopy, special techniques, CARS – applications.

Unit III

New developments in laser spectroscopy – optical quenching – trapping of atoms – spectroscopy of single ion, optical Ramsey fingers, atom interferometry, one atom Maser, squeezing.

Unit IV

Application of Laser Spectroscopy - Application in chemistry – environmental – biological – medical – technological applications.

Unit V

Nonlinear spectroscopy – linear- nonlinear absorption, saturation of in homogeneous line profile, saturation spectroscopy, polarization spectroscopy, multiphoton spectroscopy – special techniques.

Textbook:

1. Laser Spectroscopy- Basic Concepts and Instrumentation, W. Demtroder, Springer, Third Edition, 2004. Chapters 5,7,8,11,14 and 15.

Reference Books:

1. Laser Technology and Applications, S.L. Marshall, Mc. Graw Hill Book Co., 1980.
2. Laser in Industry, S.S. Charachan, Van Nostrand Reinhold Co., 1975.
3. Laser Electronics, by Joseph T. Verdeyen, PHI 1993.
4. Laser theory and applications, K. Thiagarajan and A. Ghatak, Me Millan, 1991.

PH E907 MEASUREMENT and INSTRUMENTATION

UNIT I

Physical Measurement

Measurement – result of a measurement – uncertainty and experimental error – systematic error – random error – repeated measurements – data distribution functions; mathematical description, derivation and properties – propagation error – analysis of data – multiparameter experiments.

UNIT II

Instrumentation System Design

Experiment design – transducers – characteristics of transducers – selection of transducer – modeling external circuit components – instrument probes – power measurements – measurement methods – dc and ac bridge measurements – LCR bridges – Q meter – Megger.

UNIT III

Bridges, Recorders And Transducers

Wheatstone's bridge – Kelvin's bridge – double bridge – bridge controlled circuits – digital readout bridges – AC bridges – bridges for capacitance and inductance comparison – Wien bridge – resonance bridge – types of detectors – strip chart recorders – X-Y recorders – digital data recording – recorder specifications – applications – electrical, resistive transducers – strain gauges – RTD – thermistor – LVDT – pressure inductive transducers – capacitive transducer (pressure) – load cell (pressure cell) – piezo electric, photoelectric and photo-voltaic transducers – photo diode and photo transistor – temperature and frequency generating transducers – flow measurements.

UNIT IV

Instrumentation Electronics

Op-amps – instrumentation amplifier – signal conditioning – filters - analog signal processing – high speed A/D conversion – D/A conversion – digital logic levels – digital instrumentation – frequency measurements – FFT – sampling time and analyzing – IEEE 488 interface bus – LabView (basics) – nuclear instrumentation.

UNIT V

Advanced Measurements

Spectroscopic instrumentation – visible and IR spectroscopy – spectrometer design – refraction and diffraction – lenses and refractive optics – dispersive elements – lasers – fiber optics – X-ray fluorescence: line spectra and fine structure – absorption and emission processes – X-ray production – X-ray diffraction and crystallography – neutron diffraction – TEM – SEM – atomic force and tunneling scanning microscope.

Text/ Reference:

1. M. Sayer and A. Mansingh, "Measurement, instrumentation and experiment design in physics and engineering", Prentice-Hall India Pvt.Ltd., New Delhi, 2000.
2. H.S. Kalsi, 'Electronic instrumentation', (2nd Edition), Tata McGraw Hill Publ.Co.Ltd., New Delhi, 2004.
3. R.F. Coughlin and F.F. Driscoll, "Operational amplifiers and linear integrated circuits", Pearson Education, New Delhi, 2001.
4. E.O. Doebelin, "Measurement systems: Applications and design", McGraw-Hill, New York, 2002.Rangan Sharma and Mani, "Instrumentation devices and systems", Tata McGraw-Hill, New Delhi, 2000.

PH E908 NANOMATERIALS: PREPARATION and CHARACTERIZATION

UNIT I

Basic Properties Of Nanoparticles:

Size effect and properties of nanoparticles - particle size - particle shape - particle density - melting point, surface tension, wettability - specific surface area and pore size – Reason for change in optical properties, electrical properties, and mechanical properties - advantages

UNIT II

Nanotubes:

Single walled and Multi walled Nanotubes (SWNT and MWNT) - synthesis and purification - synthesis of carbon nanotubes by pyrolysis techniques - arc-discharge method - nanotube properties – Nanowires – methods of preparation of nanowires –VLS mechanism

UNIT III

Nanowires And Nanofibers:

Semiconductor and oxide nanowires –preparation –solvothermal – electrochemical –PVD –Pulse laser deposition – template method (qualitative)- nanofibers –electro spinning technique

UNIT IV

Characterization:

Nano SEM - Scanning Conducting microscopy (SCM) - near-field Scanning Optical Microscopy - High-resolution Transmission Electron Microscopy (HRTEM)- Absorption and emission spectra – PL spectrum - single nanoparticle characterization –Scanning capacitance microscopy – capillary electrophoresis-laser induced fluorescence (CE-LIF)

UNIT V

Nanodevices:

Magnetic storage: magnetic quantum well; magnetic dots - magnetic date storage - high density quantized magnetic disks - magnetic super lattices – MRAMS - MTJs using nanoscale tunneling junctions – nanomaterial sensors

Text/ References:

1. "Nanoparticle Technology Handbook", Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama, Elsevier Publishers (2007).
2. "Nanomaterials Synthesis, properties and applications", Editor:- A.S Edelstein, IOP Publishing, UK (1996).
3. "Nanostructured materials and nanotechnology'', Concise Edition, Editor:- Hari Singh Nalwa; Academic Press, USA (2002).
4. "Hand book of Nanostructured Materials and Technology'', Vol.1-5, Editor:- Hari Singh Nalwa; Academic Press, USA (2000).
5. "Carbon nanotubes: preparation and properties", Editor: - T.W. Ebbesen, CRC Press, USA (1997).
6. Zhon Ling Wang, Characterization of nanophase materials, ISBN: 3527298371, Wiley-VCH Verlag GmbH (2000)

PH E909 NANOSCALE FABRICATION and TECHNIQUES

UNIT I

Scaling laws in miniaturization

Heat conduction in micro- and nano- systems: heat conduction equation, Newton's cooling law, heat conduction in multilayered thin films, heat conduction in submicron scale - Quantum phenomena in nano-systems: photonic band gap structure, quantum states in nano-sized structures, quantum transport

UNIT II

Clean room:

Need for a clean room – Types of clean rooms – maintenance of different types of clean rooms – oxidization and metallization- masking and patterning

UNIT III

Preparation techniques:

Basic micro- and nano-fabrication techniques: thin film deposition, ion implantation, diffusion, oxidation - surface micromachining, LIGA process -Packaging: die preparation, surface bonding, wire bonding, sealing, assembly Measurement techniques : scanning tunneling microscope, atomic force microscope, focused ion beam technique-nanoindentation, nanotribometer

UNIT IV

Nano-fabrication: principles and techniques:

Etching technologies - wet and dry etching - photolithography – Drawbacks of optical lithography for nanofabrication - electron beam lithography – ion beam lithography -dip-pen nanolithography, stamping techniques, strain-induced self-assembly for Nanofabrication of quantum dot and molecular architectures - Polymer processing for biomedical applications

UNIT V

Applications and devices

Mechanics for micro- and nano-systems: bending of membrane and cantilever, resonance vibration, fracture, stress, nano Tribology -Fluid dynamics for micro- and nano- systems: surface tension, viscosity, continuity equation -laminar fluid flow, fluid flow in submicron and nanoscale- Surface acoustic wave (SAW) devices, microwave MEMS, field emission display devices, nanodiodes, nanoswitches, molecular switches, nano-logic elements- Super hard nanocomposite coatings and applications in tooling- Biochemistry and medical applications: lab-on-a-chip systems.

Text/ References:

1. T.R. Hsu, MEMS & microsystems design and manufacture, Boston, McGraw Hill, 2002.
2. S.E. Lyshevski, Nano- and microelectromechanical systems, Boca Raton, CRC Press, 2001.
3. R. Waser (ed.), Nanoelectronics and information technology, Aachen, Wiley-VCH, 2003.
4. B. Bhushan, Springer handbook of nanotechnology, Berlin, Springer-Verlag, 2004.
5. J.A. Pelesko and D.H. Bernstein, Modeling MEMS and NEMS, Boca Raton, Chapman &Hall/CRC, 2003.

PH E910 NON DESTRUCTIVE TESTING

Unit I

Non Destructive Evaluation Principle, developments of methods, standards and limitations. Possible material defects in Casting, Forging and Welding Metallurgical process, Visual observation and liquid penetrant techniques – Magnetic Particle and eddy current methods: Basic principles – limitations and applications.

Unit II

Ultrasonic methods – Transducers – Ultrasonic beam profile – loss energy in transmission – probe heads – probe selection – angle beam probes – contact type probes – immersion probes – Twin element probe – focused transducers – testing techniques – pulse echo - contact, immersion through transmission – resonance methods – performance evaluation of NDT transducers – calibration blocks.

UNIT III

X ray and gamma ray radiography: X-ray film processing-film types-Geometrical factors- Penetrameters-Weld radiography-pipe radiography-reference radiography-Image intensifiers. Gamma ray radiography: Half-life –curie-Roentgen-Half value layer thickness-Gamma ray sources-Permissible exposure-Exposure calculation.

Principles of Neutron Radiography – Sources – Slow neutron beams – Neutron image detectors – flaw detection by Neutron radiography – limitation of Neutron radiography – comparison with X-ray radiography.

Unit IV

Electromagnetic Acoustic transducers – generation of various types of waves – Laser generated Ultrasonics - Thermo elastic generation of Ultrasonics – Ultrasonics in ablation regimes – Laser Ultrasonics at an angle calibration – Acoustic Emission flaw detection.

Unit V

Surface methods using electron low energy electron diffraction (LEED)-reflection high energy electron diffraction (RHEED)-Neutron diffraction technique:neutron spectrometer-neutron diffraction in hydrogeneous matter-detection of antiferroemagentism

Text Books:

1. Ultrasonic Testing of Materials, J. Kraut Kramer and H. Kraut Kramer, Narosa Publishing House, New Delhi 1993.
2. Non Destructive Testing , Hull .B and John V.B., , Mc Millan ELBS, 1998.
3. Transducer for Ultrasonic Flaw Detection, V.N. Bindal, Narosa Publishing House, New Delhi 1999.
4. Practical Non Destructive Testing, Beldevraj, Jayakumar and Thavasimuthu, Narosa Publishing House, New Delhi 2007.
5. Surface Physics, Prutton M, Clarenden Press, Oxford, 1975.
6. X-ray and Neutron diffraction, Bacon, GE, Pergamon Press, 1966.
7. Non Destructive Testing of welds, Beldevraj and Jayakumar, Narosa Publishing House, New Delhi 2000.

Reference Books:

1. Non-Destructive Testing of Examination- Hand Book, Edr. Knud.G.Boving, Jaico Pub. House, New Delhi, 1995.
2. Principles of Neutron Radiography, N.D. Tyufyakov, and A.S. Shtan, Amerind Pub. Co. New Delhi, 1979.
3. Neutron Radiography – a Monograph, IGCAR Kalpakkam, Sep. 1999.
4. Treatise on Materials Science and Technology, Vol. 27, " Analytical technique for thin films", Academic Press, Inc., New York, 1991.

PH E911 SEMICONDUCTOR DEVICE TECHNOLOGY

UNIT I

Bipolar Devices

P-N junction under Zero bias condition – V-I characteristics - Depletion Capacitance - Diffusion capacitance - Tunneling and Tunnel diodes - Schottky barriers – Ohmic contacts – UJT: Principle and operation- V-I characteristics - Bipolar junction transistors (BJT): Principle of operation, doping profile – doping profiles –BJT as a amplifier - BJT as a switch.

UNIT II

Unipolar Devices

FET: Basic principle – General characteristics of JFET and MOSFET – charge – coupled Devices (CCD) – MOSFET – Principle and operation - Structures – Advanced in MOSFET's – effect of gate and Drain voltage on carrier mobility.

UNIT III

Photonic Devices / Optoelectronics

Introduction- Crystalline solar cells – solar radiation and ideal Conversion efficiency – PN-Junction solar cells – hetero junction, interface and thin film solar cells- amorphous silicon solar cells –LEDs – Semiconductor lasers – Photo detectors –Photo diode- PIN photo diode.

UNIT IV

Transistor structures

Electron transport in short devices and compound semiconductor technology – Permeable Base Transistors – Planar doped barrier devices – Real space transfer and hot electron injection transistors– Super lattice devices – Resonant tunneling devices.

UNIT V

Fabrication Technology

Purity of silicon- Wafer Preparation, Etching, Photolithography-Epitaxial growth-ohmic contacts- Fabrication of resistors and capacitors ICs– Thin film technology.

Text Books:

1. Physics of Semiconductor Devices – Michael Shur, Prentice Hall India 1995.
2. Physics of Semiconductor Devices – S.M.Sze, 2nd Ed Wiley – interscience ltd (2004).
3. Semiconductor Devices; An Introduction – Jasprit Singh, Mc.Graw Hill, (1994).

Reference Books:

1. Semiconductor Physics and Devices – Basic principles – Donald A. Neamen 3rd Ed. Tata Mc graw Hill (2005).
2. Semiconductor Devices, Kanaan Kano, - pearson Education, Inc. (2004).
3. Physics of Technology of Semiconductor Devices – Andrew S.Grower.

PH E912 SENSOR TECHNOLOGY

Unit I

Load cell – pressure transducers – Bourdow tubes – diaphram elements – Bell gauge – Electrical types, Mechanical types – Low pressure measurements – mechanical, electrical and thermal types – ionization gauges – differential pressure transducers.

Unit II

Sensors for displacement – velocity – acceleration and torque – electrical transducers for displacement – strain gauges – capacitance gauges – LVDT – Piezo electric transducers – measurement of quantities.

Unit III

Temperature Measurement: Solid and fluid expansion type – resistance thermometers – thermo emf – thermisters – radiation pyrometers – thermography – measurement of very high or Stellar temperature.

Unit IV

Flow and level measurements: Head types – Installation procedure – pitet tubes – area and mass flow meters – Positive displacement flow meters – electrical turbo magnetic and electromagnetic flow meters. Hot wire anemometers – open channel flow. Float type level measurement – displacement type – hydrostatic types – thermal effect type – electrical methods and magnetic methods.

Unit V

Materials for Transducers: Barium Titanate KDP, ADP, PDVE films, TaS, thermal sensors of ABO_3 type, Wurtzite etc.

Text / Reference Books:

1. Principles Industrial Instrumentation, D. Patranaris, Tata McGraw Hill, New Delhi, 1991.
2. Measurement Instrumentation and Experiment design in Physics and Engineering, M. Sayer and Abhai Mansingh, Printice Hall Pvt. Ltd, 2000.
3. Instrumentation and Devices, C.S. Rangan, G. Sharma and Mani , Tata McGraw Hill, New Delhi, 1985.
4. Physical Properties of Materials, Lovell, et al, ELBS, 1984.

PH E913 SOLID STATE IONICS

UNIT I

Basic Aspects Of Solid State Physics

Types of bonding in solids-Fundamentals of Crystallography-Simple Crystal structures, X-ray diffraction-band structures of metals, semiconductors and insulators-Ionic and electronic conductivities.

UNIT II

Solid State Ionics

Concept of solid state ionics- Importance of super-ionic materials and structures-Classification of Super ionic solids-Experimental probes pertaining to solid state ionics- Theoretical models of fast ion transport- Applications of fast ionic solids-Hydrogen storage materials- Nano-ionic materials.

UNIT III

Micro Batteries And Application

Concept of a thin film solid state battery- electrolyte thin films- flash evaporation technique-pulsed laser deposition technique-applications-electromotive force-reversible cells-free energy changes-capacity of a cell-power and energy density of a cell-polymer electrolytes-application of polymer electrolytes in micro batteries, Fuel cells-solid state battery-super capacitors.

UNIT IV

Characterization Of New Battery Materials

Phase identification- Thermal analysis-DTA-DSC-TG- Energy dispersive X-ray fluorescence spectroscopy (EDX)-Atomic absorption (AAS)-Rutherford Back scattering spectroscopy-X-ray photoelectron spectroscopy-Structural characterization-XRD-Electron microscopy, local environment studies-Extended X-ray absorption fine structure-FTIR-Transport measurements-Electrical transport-transient transport.

UNIT V

Applications Of Ionic Materials

Primary lithium batteries-lithium sulphur dioxide, Li-Vanadium Pentoxide, Secondary lithium batteries-Li-ion electrode materials-preparation and fabrication- -characterization of Li-ion cells- Comparison of Li-iodine and NiCd cells in CMOS-RAM applications. Applications of Lithium batteries in electronic devices, electric vehicle, fuel cells, sensors -Solar energy conversion devices.

Text/ References:

1. H.V.Keer, Principles of solid state physics, Wiley Eastern Ltd, New Delhi, 1993.
2. S.Chandra, Superionic solids-Principles and applications, North Holland Amsterdam (1981)
3. D.S.Clive, Modern Battery Technology, Alean International Ltd, Banbury, Elis Horwood Publishers,(1991)
4. T.R.Crompton, battery reference book, Reed Educational and Professional publishingLtd, SAE International 1996
5. Ozin, Geoffrey.A, Arsenault, Andre C, Nanochemistry, A chemical approach to Nanomaterials, Springer (2005)

PH E914 STRUCTURE and PROPERTIES OF ALLOYS

UNIT I

Solid Solutions

Concept of solid solution-solid solutions of Copper and Iron - Cu-Ni phase diagram - cast cupro nickel microstructures - properties of annealed copper solid solution alloys -soft magnetic alloys-stainless steels.

UNIT II

Eutectic Alloys

Pb-Sb phase diagram and microstructure - Pb-Sn phase diagram - Cu:O system - ternary Pb-Sn-Sb phase diagram - characteristic properties of eutectic system alloys -applications of Pb-Sn and Pb-Sn-Sb alloys.

UNIT III

Cast and Wrought Alloys

Al-Si phase diagram - Al-Cu phase diagram -coherency theory of age hardneing - microstructures -cast aluminium alloy -properties-residual stresses and relaxation.

UNIT IV

Two Phase Alloys

Cu-Zn phase diagram – Cu-Zn alloy structure - Cu-Sn and Cu-Al alloy systems and their microstructures -properties of brasses, tin brasses and aluminium bronzes.

UNIT V

Iron-Carbon Alloys

Fe-Fe_3C phase diagram - solubility of carbon in austenite and ferrite-terminology-equilibrium and non equilibrium - microstructures-properties of normalised steels - grain size of steels-engineering applications of low carbon steels and low alloy high strength steels

Text/ References:

1. Structure and Properties of Alloys, R.M.Brick and Arthur Philips, MCGraw Hill Book Co. inc, New york, 1985.
2. Solid State Physics - Structure and properties of materials, M.A.Wahab, Narosa publishing house, New Delhi, 1999.
3. Heat Treatment - Principle and Techniques, T.V.Rajan, C.P.Sharma and Ashok Sharma, Prentice Hall of India pvt. Ltd., New Delhi, 1995.
4. Materials Science and Processes, M.K.Muralidhara, Dhanpat Rai publishing company, New Delhi, 1998.
5. Charlie Brooks, R,Heat Treatment, Structure and properties of non ferrous alloys, American Society for Metals, U.S.A, 1984.

PH E915 THERMODYNAMICS

Unit I

System control volume, process cycles, homogeneous – heterogeneous system, quasi static process – continuum concept, zeroth law of thermodynamics – concept of temperature- pressure-volume diagram- $pv = c$, $pv^n = c$, $pv^\gamma = c$, ideal gas, temperature work and heat transfer, path and point function, work done in free expansion – zero work transfer, work transfer-heat transfer as a path function.

Unit II

First law of thermodynamics – system undergoing change of state, energy a property- specific heat at constant volume and constant pressure –PMMI, Second law of thermodynamics- cycle, difference between heat and work, efficiency of heat engine, Kelvin Planck, Clausius statement - refrigerator- heat pump- COP, equality of Kelvin Plank and Clausius statement, reversibility, irreversibility -causes, Carnot's cycle- Carnot's theorem, equality of thermodynamic scale and Kelvin scale of temperature.

Unit III

Entropy- Clausius theorem, entropy as a property, T-S diagram, Clausius inequality, change in entropy in irreversible process, entropy principle –application, maximum work obtainable, change in entropy with heat flow, change in entropy of closed system-open system, directional law of nature, entropy and disorder, available energy, quality of energy, maximum work done in reversible process with heat exchange, dead state.

Unit IV

Pure substance- gases and mixtures, P-V diagram of water and other substances, P-T diagram, PVT diagram, TS diagram, HS diagram (Mollier chart) dryness fraction, steam tables, saturation state-liquid vapour mixture, super heated liquid, Compressed liquid, thermodynamic properties chart, equation of state, ideal gas – specific heat at constant pressure, internal energy, enthalpy and entropy change of ideal gas, reversible adiabatic-isothermal process, change in entropy in poly tropic process, virial expansion, law of corresponding states.

Unit V

Mixture of gases-Daltons law of partial pressure, internal energy, enthalpy, specific heats at constant pressure and volume change in entropy of mixtures, Gibb's function, Maxwell's equations, TdS equation, $C_p - C_v$, C_p/C_v, energy equation, Joule Kelvin effect, Clausius Clapeyron equation, mixture of variable composition, equilibrium conditions of heterogeneous system, Gibbs phase rule-types equilibria, stability condition.

Text Book:

1. P.K. Nag, Engg. Thermodynamics Tata .Mc. Graw Hill 1995.

Reference books:

1. Zemansky M.W., Heat and Thermodynamics, Mc. Graw Hill 1957.
2. Evelin Guha, Heat and Thermodonamics T.Mc. Graw Hill, 1998.
3. Arora C.P. Heat and Thermodynamics, Tata Mc. Graw Hill, 1998.
4. Huang F.F. Engg. Thermodynamics, Mac Millan, 1989.
5. Adrian Bejan, Advance Engg. Thermodynamics, John Wiley, 1988.

PH C908 MATERIALS SCIENCE LABORATORY I

[Any TEN experiments]

1. Determination Band Gap of Semiconductor – Reverse biased PN Junction Diode
2. Hall effect – Hall Coefficient & Mobility
3. Magnetic Susceptibility of liquids - Quincke's method
4. Thermister Characteristics
5. Laser Experiments – Wavelength and Particle Size Determination
6. Electrical Conductivity of Electrolytes using Conductivity Meter
7. Dielectric Constant of liquids using Capacitance Meter
8. Guoy Balance – Determination Paramagnetic Susceptibility.
9. Determination of elastic constants – Hyperbolic fringes/ Elliptical fringes
10. Determination of dielectric constant of ADP and KDP Crystals
11. Ultrasonic Diffractometer - Ultrasonic velocity in liquids
12. Study of crystal lattices – Using Space Lattice kit and Models
13. Strain gauge meter – Determination of Young's modulus of a Beam
14. Resistivity of Metal, Semiconductor and Oxide – Comparative Study
15. NDT – Ultrasonic flaw detector

PH C909 MATERIALS SCIENCE LABORATORY II

[Any TEN experiments]

1. Band gap determination of P-type/ n-type semiconducting wafer (four probe method)
2. Thermolunimescence study of Alkali Halides
3. Determination of Specific Charge of an Electron (e/m Thomson's method)
4. Determination of Absorption coefficient of air and aluminum using GM counter.
5. Error Analysis
6. Differential Thermal Analysis
7. Dielectric Constant of a Crystal– Frequency Variation using LCR Meter
8. Electrical conductivity study of solids (ionic / semiconducting) using two probe.
9. Magnetic susceptibility of Ferro fluids
10. Determination of wave length of laser – Using Reflection & Transmission Grating
11. Determination of wavelength of Hydrogen Arc spectrum using constant deviation spectrometer.
12. Determination of coefficient of viscosity of Ferro fluids using Spindle Viscometer
13. X -ray powder method – indexing and cell determination
14. Preparation of buffer solutions and pH measurements.
15. Fermi Surface/ DOS of simple elements by *ab initio* calculations

CH E901 CERAMIC MATERIALS

Unit I

Nature of Ceramic materials – crystalline ceramic materials – Silicates and clay minerals and spinal structures – Polymorphic transformations – glass and non-crystalline phases – structure and Composition of glass – Surface and Interface.

Unit II

Ceramic raw materials – clay materials – Silicate and Silicate minerals - Synthetic raw materials – Oxide (like Al_2O_3, ZrO_2, TiO_2, MgO) and non-oxide (like Si_3N_4, AlN, BN, SiC) raw materials. Synthetic techniques – Sol – gel processing, liquid – phase reaction and hydrothermal synthesis.

Unit III

Processing of Ceramics – powder pressing, slip casting, firing- thermal treatment procedure – drying, sintering, annealing – Viscosity based transition points in glass – glass forming methods, glass- ceramics.

Unit IV

An outline of ceramic equilibrium diagrams – One component (SiO_2), two component (Al_2O_3, Cr_2O_3, MgO-CaO, MgO-Al_2O_3, Al_2O_3-SiO_2, Al_2O_3-BeO) and qualitative ideas of methods of representation of three component diagrams – Nucleation – grain growth.

Unit V

Mechanical properties of Ceramic materials – Elastic properties and strength – Griffith's theory – plastic and viscous deformations – strengthening of glass.

Thermal properties – thermal expansion, heat capacity and thermal conductivity – thermal stresses. Electrical and Magnetic Properties of Ceramic Materials – Ceramic insulators and capacitors, Ferro electric ceramics, varistors, spinal ferrites and garnets.

Text Books:

1. L.H. Van Vlack – Physical Ceramics for Engineers – Addison Wesley, 1964.
2. F.H. Norton – Elements of Ceramics - Addison Wesley, 1974.

Reference Books:

1. W.D. Kingery, H.K. Bowen, D.R. Uhlmann – Introduction to Ceramics – 2nd edition, John Wiley & Sons, 1991.
2. D. Ganguli and M. Chatterjee – Ceramic powder preparation|: A hand book – Kluwer Academic Publishers, 1997.
3. David Segal – Chemical Synthesis of advanced Ceramic Materials – Cambridge University Press – 1989.
4. A.R.West, Solid State Chemistry and its Application - John Wiley & Sons, 1984.
5. James S Reed, Principles of Ceramic Processing, John Wiley & Sons Inc, NY, 1995

CH E902 POLYMERS and COMPOSITE MATERIALS

Unit I

Fundamental concepts of Polymers and Composites:

Introduction – classification of Polymers and composites – Types of Polymerization and Mechanisms – Molecular weight of Polymers – Number average and Weight average concepts – Degree of Crystallinity and Glass transition temperature of Polymers – Relationship between Tg and Tm

Unit II

Fabrication:

Compounding of plastics – injection, compression moulding – Preg moulding – Blow Moulding – calendaring and lamination techniques of plastics – Fabrication methods of composites – powder metallurgy, hot pressing, hot rolling, co-extrusions, fiber reinforced metals.

Unit III

Testing of Polymers and Composites:

Testing of Polymers – Chemical identification methods – tensile and bending strength – impart resistance – fatigue – dielectric strength – Testing of Composites – stress distribution and load transfer – prediction of strength of impurities – anisotrophy – failure criteria.

Unit IV

Properties of Polymers and Composites:

Properties of polymers – strength – plastic deformation – mechanical, optical and electrical properties with reference to important engineering plastics – LDPE, HDPE, PVC, Polyester, Phenol formaldehyde, alkyds, cellulose, silicones, epoxy resin and elastomers – Properties of Composites – micro mechanics, inter phase band.

Unit V

Application of Polymers and Composites:

Application of Polymers and plastic fibers – elastomers – coating adhesives – bio medical application - fiber reinforced plastic – conducting polymers and fire retarding polymers.

Applications of Composites: Aircraft engineering – space hardware – wind turbine – marine craft – space structure – applications in biomedical field.

Text / Reference Books:

1. Text Book of Polymer Science, Fred. W. BillMeyer, Jn. Wiley Interscience, 1994.
2. Introduction to Polymer Science, A.R. Gowarikar. etal, Tata McGraw Hill Book co., India.
3. The Science and Engineering of Materials, Donald R. Askeland, PWS –KENT Publishing Company, Boston, 1980.
4. An Introduction to Composite Materials, Derek Hull, Cambridge University Press, 1988.
5. Composite Materials: Engineering and Science, Mathews, F.L., Chapman & Hall, 1994.
6. Composite Materials Hand Book, M.M. Schwartz, McGraw Hill Book Co., 1984.
7. Joel R.Fried, Polymer Science and Technology, Prentice-Hall, New Jersey, 1995

CE C901 STRENGTH OF MATERIALS LABORATORY

1. Tension test on mild steel & R.T.S rod
2. Tension test on mild steel wire, non ferrous metals and plastics
3. Cold bend test on mild steel rods and flats
4. Impact test on metals (Charpy and Izod's test) and on plastics
5. Rockwell and Brinnels hardness test for ferrous, Non ferrous,, Alloy specimens
6. Determination of spring constant.
7. Compressive strength of cement concrete by Rebound hardness tester
8. Compressive strength evaluation of cement concrete by ultrasonic pulse velocity

CE E902 STRENGTH OF MATERIALS

Unit I

Concept of mechanics of deformable bodies – behavior of mild steel under tension – stress and strain definition – elastic constants and their relationships – equivalent modulus – principal stress and principal plane

Unit II

Simple stress and strains of uniform bar, taper bar, conical bar – composite members – load stress & strain – thermal stress & strain

Unit III

Bending moment and sheering force diagrams for cantilever, simply supported and overhang beams – theory of simple bending – neutral axis – stress distribution across a section due to bending

Unit IV

Sheer stresses due to bending – stress variation in rectangular beam – combined direct and bending stress – eccentricity to one axis

Unit V

Thin cylindrical shells – hoop stress – longitudinal stress – change in dimension due to internal pressure – thick cylindrical shells – Lame's theory – longitudinal and shear stress

Text Books:

1. Rajput R K, Strength of Materials, S Chand & Co, New Delhi, 2002
2. Bhavikatti S S, Strength of Materials, Vikas Publishing House (P) Ltd, 2002

ME C901 WORKSHOP PRACTICE

Fitting Shop:
Study of hand tools like files, chisels, hammers, try square, calipers, hacksaw, marking gauge, punches, tapes, dies etc. use of vernier calipers and micrometers. Use of tools – cutting and filing of M.S. Strips to correct profiles – drilling and tapping

Welding Shop:
Study of welding, soldering and brazing making of lab, butt, of M.S. flats by gas and arc welding. Elementary practice of soldering and brazing (demonstration)

Metal Cutting:
Sand moulding exercises – two box types – demonstration – molten metal pouring and casting. Metal cutting – exercises on lathes – turning, joining, drilling and taper turning.

ME E902 METALLURGY

UNIT I
Defects in solids: Imperfections in solids – Point defects – vacancies – Frenkel and Schottky defects – dislocations – geometry of edge and screw dislocations – Burger vector – energy of a dislocation – stress to move a dislocation – critical resolution shear stress – slip systems in crystalline solids – dislocation multiplication stacking faults and twins.

UNIT II
Classification of alloys – Hume-Rothery rules – dendrites – constitutional super cooling – segregation and zone refining – formation of solid solutions – intermediate phases.

UNIT III
Phase diagrams: Free energy composition curves – Lever rule – Eutectic, peritectic and peritectoid systems – Solid state reactions –important of equilibrium diagrams – Effect of alloying elements on the Fe- C diagram- Fe-C system – Copper alloys – Magnesium alloys – Experimental determining of equilibrium diagrams – Non-equilibrium structure – TTT diagram – Hyper eutectoid steels.

UNIT IV
Annealing, Normalising, Hardening, Spheroidising, Martempering and Austempering. Hardness and hardenability. Hardenability test Casehardening processes – Carburising, cyaniding and carbonitriding, nitriding, Flame hardening and induction hardening.

UNIT V
Categories of phase – diffusion in solids – nucleation and growth kinetics-bainitic transformations- martensitic transformations-– Recovery, recrystallization and grain growth – plastic deformation mechanisms – fracture – fatigue failures -Powder metallurgy and sintering metallic glasses.

Text Books:

1. Van vlack, Elements of Materials Science, Addison & Wesley, 1964.
2. Raghavan, Physical Metallurgy – Principles and Practice, Prentice Hall India, 1993.
3. Raghavan, Materials Science and Engineering, PHI Private Limited, New Delhi, 2003.

References:

1. A.C. Guy and Hren, Elements of Physical Metallurgy, Oxford University Press, 1974
2. S.Clark and R.Varnery, Physical Metallurgy, Affiliated East Press, 1962
3. R.E.Reedhill, Physical Metallurgy Principles, Affiliated East West Press, New Delhi,1973
4. John Wulff et al., The structure & properties of Materials, Vol.II, John Wiley, 1964.
5. Irving Granet, Modern Materials Science, Reston Publishing Co., 1980
6. S.H.Avner, Physical Metallurgy, McGraw Hill, 197
7. Donald R.Askeland, PradeepP.Fulay, D.K.Bhattacharya ,Materials science and Engineering , cengage learing publishing -2010

ME E903 CORROSION SCIENCE and ENGINEERING

UNIT I

Importance of corrosion prevention in various industries: The direct and indirect effects of corrosion – The free energy and oxidation potential – the pilling Bed work ratio and it consequences – corrosion rate expressions – The importance of pitting factor – Pourbaix diagrams of Fe – Their and limitations

UNIT II

Localized corrosion: The electro chemical mechanism Vs. The chemical mechanism – Galvanic corrosion – prediction using emf Series and Galvanic series – Crevice corrosion – Mechanism of differential oxygenation corrosion – Auto catalytic mechanism of pitting due to crevice or differential oxygenation corrosion –

Principles and procedures of cathodic protection: Sacrificial anodes and external cathodic current impression – stray current corrosion

UNIT III

Intergranular corrosion: Stainless steels – cause and mechanism (Cr- Depletion theory) – Weld decay and knife line attack – Stress corrosion and fatigue corrosion – Theory of critical corrosion rate in corrosion fatigue.

Uniform corrosion - Pitting corrosion - erosion corrosion- Fretting damage – Cavitation damage- hydrogen damage. High temperature Oxidation of metals – Ionic diffusion through protective oxides – Classification on the basis of kinetics or rates of oxidation.

UNIT IV

Kinetic aspects of corrosion: Exchange current density - activation polarization and concentration polarization– combined polarization -Mixed potential theory – Phenomenon of passivation – Theories – effect of oxidizing agents and velocity of flow on passivating metals – Tafel extrapolation – linear polarization.

UNIT V

Corrosion in inhibition: Inhibiters of corrosion – passivators, adsorbing inhibiters, V.P. inhibiters. Bacterial corrosion – Marine corrosion – Control methods. Control of Bacterial corrosion -Corrosion prevention by Coatings – Surface pre- treatment – Hot dip, diffusion and cladded coatings – Phosphating and its uses. thermal spray coating –high velocity oxyfuel coating (HVOF) –thermal barrier coating.

Text Books:

1. Uhlig H.H, “Corrosion and its control”, Willey, 1985.
2. Fontanna, “Corrosion Engineering”, (Materials Science and Metallurgy series), third edition, McGraw Hill inter national Ed., 1987
3. Kenneth R. Trethewey and John Chamber lain, “Corrosion for Students of Science and Engineering”, Long Mann Scientific and Technical edition, 1988.

Reference Books:

1. Pludek, “Design and corrosion prevention”, McMillan, 1978.
2. Raj Narain, “Introduction to metal corrosion”, Oxford IBH, 1983
3. A.S. Khanna “Introduction to high temperature oxidation and corrosion” , ASM International , 2002

CS C901 PROGRAMMING IN C

Unit I

Introduction and Importance of C language – Basic structure of C programs – Data types – Constants – Variables – Operators – Arithmetic operators – Precedence of arithmetic operators – Type conversions in expressions – Operator precedence and associativity.

Unit II

Control statements – if- else, switch –case, loop statements – for loop, while loop, do-while – Control breaking statements: break, continue and goto – Functions and program structures – Types of functions – return statement – Actual and formal arguments – Recursive functions Local and global variables – Scope of Variables – Automatic, register – static – external. Preprocessors – Macros and standard functions.

Unit III

Arrays – Introduction – One-dimensional arrays – Two-dimensional arrays – initializing two-dimensional arrays – Multidimensional arrays.

Pointers – understanding pointers – Pointer expressions – Pointers and arrays – Pointers and Character Strings – Pointers and functions – Pointers and structures – Points on pointers.

Unit IV

File management in C – Defining and opening a file – Closing a file – Input/ Output operations on files – Error handling during I/O operations – Random access to files – Command line arguments – Dynamic memory allocations.

Unit V

Numerical analysis – Symbolic manipulation – Minimization and maximization of a function – root finding – set of linear algebraic equation – Numeric solutions – collection and analysis of data – Error, accuracy and stability – Modeling of data – least square fitting – non linear fitting – fitting of data to a straight line data with error in both the co-ordinates. Problems solving using packages (Matlab & Mathematica).

Introduction to simulation – methods – deterministic and stochastic – construction of a model – calculation and analysis of physical properties using the model - Application

- Motion of a falling object (force and distance calculations)
- Nuclear decay (mass and energy)
- Bohr atom model (energy eigen values)
- Classical and Quantum linear harmonic Oscillators (Non- linearity).

Books:

1. Programming in C – D. Ravichandran, New age International, New Delhi –1999.
2. Programming with C – E.. Balagurusamy, Tata Mc Graw Hill, New Delhi –1999.
3. Programming with C – Byron Gottfried, Schaums' Outline Series, TMH-1999.
4. Working with C – Yashavant Kanethkar, BPB, New Delhi – 1994.
5. Programming with ANSI C – Brian Kernigham and Dennis Ritchie – PHI – 2000.
6. Introduction to numeric methods by M.K. Venkataraman.
7. Numerical Receipes in C (the art of Scientific Computing) by William. H Press etal, Cambridge University Press, India (1996).
8. Introduction to Computer Simulation methods – application to Physical Systems Part I and Part II by Harvey Gould etal, Addison Wesley Publish Co.
9. Computational Physics by K.H. Hoffmann and Schrieber Springer Verlag.

CS C902 PROGRAMING LABORATORY

C – Language

1. Sine series
2. Binomial coefficients
3. Transpose of a given matrix
4. Inverse of a given matrix
5. Diagonalisation of a matrix
6. Newton-Raphson method and other iteration methods
7. Reading of data from Binary ASCII to data file – Elementary graphics and plotting
8. Curve fitting – least square, non least square
9. Numerical integration, Trapezoidal rule and Simpson's rule
10. Bisector
11. Solution of Ordinary differential equation Range – Kutta method
12. Advanced graphics: Ellipse, circle and colour filling.

E&I C901 INSTRUMENTATION LABORATORY

1. Instrumentation Amplifier
2. Frequency meter
3. LVDT
4. Thermocouple and RTD
5. Anderson & Hay's Bridges
6. Maxwell's & Schering Bridges
7. Calibration of wattmeter and energy meter
8. Clippers and clampers
9. Simulation of filters
10. Simulation of amplifiers