DEPARTMENT OF NANOSCIENCE AND TECHNOLOGY

M.Sc. NANOSCIENCE AND TECHNOLOGY

(The curriculum is offered by the University Department under CBCS)

The students admitted during the academic year 2011 - 12

PREAMPLE

The eligibility condition for admission to our M. Sc. Nanoscience and Technology course is any science degree (B.Sc.) with mathematics as one of the subjects at least at + 2 levels. Hence students with B. Sc. Degree in Physics/Chemistry/Biotechnology/Biochemistry/Biology/ Microbiology are eligible for the M. Sc. Nanoscience and Technology course. To acquire sufficient knowledge to write GATE/CSIR/UGC/SLET/ NET examinations, these students should study core papers in Physics or Chemistry or Biotechnology in addition to their knowledge in Nanoscience and Technology. In order to meet this goal, suitable modifications are made as given below, in the curriculum of M. Sc. Nanoscience and Technology course.

Total number of Core and Elective papers apart from Practical - 15

Papers from core Physics/Chemistry/Biotechnology - 8

Specialized papers from Nanoscience and Technology - 7

Accordingly a student of M.Sc. Nanoscience and Technology course with a B.Sc. degree in Physics is studying eight core Physics papers like Condensed Matter Physics, Electronics, Electromagnetic Theory, Nuclear and Particle Physics, etc ., apart from eight papers in Nanoscience and Nanotechnology.

Similarly a student with B.Sc. Chemistry is studying eight core Chemistry papers and eight Nanoscience papers. Likewise a student with a Biology degree is exposed to eight papers in core Biotechnology.

The contents of the papers in core Physics/Chemistry/Biotechnology are fully adopted from the syllabi of the respective M.Sc. degree of Bharathiar University and also based on the GATE/CSIR syllabus.

M.Sc. Nanoscience and Technology degree is being awarded as detailed below according to the major specialization for the students admitted from the academic year 2011-12 onwards:

S.No.	**Major Specialization**	**Degree awarded with effect from 2011-12 batch onwards**
1	Physics	M.Sc. Nanoscience and Technology (Physics Based)
2	Chemistry	M.Sc. Nanoscience and Technology (Chemistry Based)
3	Biotechnology	M.Sc. Nanoscience and Technology (Biotechnology Based)

Scheme of Examinations (CBCS Pattern)

Sem	Code No.		Subject	Ins. hrs.	University Examination			Credit
					Int.	Ext.	Total	
I	13A		Introduction to Nanoscale Science and Technology	4	25	75	100	4
	13B	P	Classical Mechanics	4	25	75	100	4
		C	Organic Chemistry – I					
		B	Biochemistry					
	13C	P	Quantum Mechanics	4	25	75	100	4
		C	Inorganic Chemistry - I					
		B	Molecular Genetics					
	13D	P	Mathematical Physics	4	25	75	100	4
		C	Physical Chemistry - I					
		B	Cell and Molecular Biology					
	1EA		Electronics/Analytical Chemistry/ Biostatistics	4	25	75	100	4
	13P		Practical – I	6	25	75	100	4
			Supportive - I	2	12	38	50	2
II	23A		Synthesis and Characterization of Nanomaterials	4	25	75	100	4
	23B		Properties of Nanomaterials	4	25	75	100	4
	23C	P	Statistical Mechanics and Thermodynamics	4	25	75	100	4
		C	Organic Chemistry - II					
		B	Immunology					
	23D	P	Nuclear and Particle Physics	4	25	75	100	4
		C	Physical Chemistry – II					
		B	Pharmaceutical Biotechnology					
	2EB		Advanced Materials Science/ Environmental Biotechnology	4	25	75	100	4
	23P		Practical – II	6	25	75	100	4
			Supportive – II	2	12	38	50	2
III	33A		Spectroscopy	4	25	75	100	4
	33B		Nanobiotechnology	4	25	75	100	4
	33C		Micro and Nanofabrication	4	25	75	100	4
	33D	P	Electromagnetic Theory	4	25	75	100	4
		C	Inorganic Chemistry – II					
		B	System Physiology					
	3EC		Applications of Nanotechnology	4	25	75	100	4
	33P		Practical - III	6	25	75	100	4
			Supportive - III	2	12	38	50	2
IV			Project and Viva – Voce	-	-	-	300	12
			Total				**2250**	**90**

[P- Core papers for B. Sc. Physics Major Students; C - Core papers for B. Sc. Chemistry Major Students and B - Core papers for B. Sc. Biology and Biotechnology Major Students]

13A INTRODUCTION TO NANOSCALE SCIENCE AND TECHNOLOGY

UNIT I: GENERIC METHODOLOGIES FOR NANOTECHNOLOGY

Introduction and classification - What is nanotechnology? - Classification of nanostructures - Nanoscale architecture; Summary of the electronic properties of atoms and solids - The isolated atom - Bonding between atoms - Giant molecular solids - The free electron model and energy bands - Crystalline solids - Periodicity of crystal lattices - Electronic conduction; Effects of the nanometre length scale - Changes to the system total energy - Changes to the system structure - How nanoscale dimensions affect properties.

UNIT II: CARBON NANOSTRUCTURES

Introduction; carbon molecules – nature of the carbon bond – new carbon structures; cabon clusters – small carbon clusters discovery of C_{60} – structure of C_{60} and its crystal – alkali doped C_{60} – superconductivity in C_{60} – large and smaller fullerenes – other buckyballs; carbon nanotubes – fabrication – structure – electrical properties – vibrational properties – mechanical properties; applications of carbon nanotubes – field emission and shielding – computers – fuel cells – chemical sensors – catalysis – mechanical reinforcement.

UNIT III: INORGANIC NANOSTRUCTURES

Overview of relevant semiconductor physics - Quantum confinement in semiconductor nanostructures - The electronic density of states - Fabrication techniques - Physical processes in semiconductor nanostructures - The characterisation of semiconductor nanostructures - Applications of semiconductor nanostructures.

.UNIT IV: NANOSTRUCTURED MOLECULAR MATERIALS

Introduction; Building blocks - Principles of self-assembly - Self-assembly methods to prepare and pattern nanoparticles - Templated nanostructures - Liquid crystal mesophases - Macromolecules at interfaces - The principles of interface science - The analysis of wet interfaces - Modifying interfaces - Making thin organic films - Surface effects on phase separation - Nanopatterning surfaces by self-assembly - Practical nanoscale devices exploiting macromolecules at interfaces .

UNIT V: EVOLVING INTERFACES OF NANO

Nanobiology - Introduction - Bio-inspired nanomaterials - Interaction Between Biomolecules and Nanoparticle Surfaces - Different Types of Inorganic Materials Used for the Synthesis of Hybrid Nano-bio Assemblies - Applications of Nano in Biology - Nanoprobes for Analytical Applications - Current Status of Nanobiotechnology - Future Perspectives of Nanobiology; Nanosensors - Introduction - What is a Sensor? - Nanosensors - Order from Chaos - Characterization - Perception - Nanosensors Based on Quantum Size Effects - Electrochemical Sensors - Sensors Based on Physical Properties - Nanobiosensors - Smart Dust; Nanomedicines - Introduction - Approach to Developing Nanomedicines - Various Kinds of Nanosystems in Use - Protocols for

Nanodrug Administration - Nanotechnology in Diagnostic Applications - Materials for Use in Diagnostic and Therapeutic Applications - Future Directions.

Reference

1. Nanoscale Science and Technology, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd., UK, 2005.
2. Introduction to Nanotechnology, Charles P. Poole Jr and Frank J. Owens, Wiley Interscience, 2003.
3. Bio-Inspired Nanomaterials and Nanotechnology, Edited by Yong Zhou, Nova Publishers.
4. Nano:The Essentials: Understanding Nanoscience and Nanotecnology, T.Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.

13B(P) CLASSICAL MECHANICS

UNIT–I: MECHANICS OF SINGLE AND SYSTEMS OF PARTICLES

Newton's laws of motion - Mechanics of a particle - Equation of motion of a particle - Motion of a particle under constant force and alternating force - Mechanics of systems of particles - Angular momentum of the system - Potential and kinetic energies of the system - Motion in a central force field - Motion of two particles equivalent to single particle - Equation of motion of centre of mass with respect to centre of force - Motion in an inverse-square law force field - Classification of orbits

UNIT–II: COLLISIONS OF PARTICLES AND MOTION OF RIGID BODY

Elastic and inelastic scattering - Laboratory and centre of mass systems - Relations between different quantities in the laboratory and centre of mass systems - Inelastic scattering in the laboratory frame - Motion of a rigid body and Euler's theorem - Angular momentum and kinetic energy - Inertia tensor - Euler's equation of motion - Free motion of rigid body – Euler's angles

UNIT–III: LAGRANGIAN AND HAMILTONIAN FORMULATIONS

Hamilton's variational principle - Lagrange's equations of motion –Conservation theorems and symmetry properties – Cyclic coordinates - Application of Lagrange's equation; Linear harmonic oscillator, particle moving under a central force, Atwood's machine - Hamilton's equations of motion - Application of Hamiltonian's equations of motion; Double pendulum, Particle moving in an electromagnetic field - Phase space - Principle of least action

UNIT-IV: CANONICAL TRANSFORMATIONS AND POISSON BRACKETS

Canonical transformations – Generating function – Properties of canonical transformations – Poisson brackets – Properties of Poisson brackets – Constant of motion using Poisson brackets – Poisson brackets of canonical variables – Poisson's Theorem – Invariance of Poisson bracket under canonical transformation – Motion as successive canonical transformation (Infinitesimal generators) – Liouville's theorem - The Hamilton–Jacobi equation – Action and angle variables

UNIT–V: SMALL OSCILLATIONS AND SPECIAL THEORY OF RELATIVITY

Small oscillations - Stable and unstable equilibrium - Lagrange's equation of motion for small oscillations - Normal coordinates and normal frequencies - Small oscillations of particles on string - Free vibrations of linear triatomic molecule – Basic postulates of special theory of relativity – Lorentz transformation – Kinematic effects of Lorentz transformation – Relativistic generalisation of Newton's law.

Books for Study and Reference

1. Introduction to Classical Mechanics, R. G. Takwale and P. S. Puranik, Tata McGraw-Hill, New Delhi, 2006.
2. Classical Mechanics by Herbert Goldstein, Charles Poole and John Safko, Pearson Education and Dorling Kindersley, New Delhi, 2007.
3. Classical Mechanics, Gupta Kumar, Sharma, Pragati Prakashan, New Delhi, 2001.
4. Classical Mechanics, John R. Taylor, University Science books, India, 2005.
5. Classical Mechanics, R. Douglas Gregory, Cambridge University press, India, 2008.

Tutorial (This portion is not intended for examination)

1. A particle is projected vertically upwards with speed u and moves in a vertical straight line under uniform gravity with no air resistance, find the maximum height achieved by the particle and time taken for it to return to its starting position.
2. A body of mass m is suspended from a fixed point by a light spring and moving under uniform gravity. The spring is found to be extended by a distance b. Find a period of oscillations of the body about this equilibrium position (assume there is a small strain).
3. Find the moment of inertia of a uniform circular disk of mass M and radius a about its axis of symmetry.
4. Find the kinetic energy of rotation of a rigid body with respect to the principle axes in terms of Eulerian angles.
5. Find the equation of motion of harmonic oscillator using Hamilton–Jacobi method.
6. Simple pendulum with rigid support, and with variable length

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13B (C) ORGANIC CHEMISTRY - I

UNIT–I: ALIPHATIC AND AROMATIC NUCLEOPHILIC SUBSTITUTION REACTIONS

Bonding - structure and reactivity - acids and bases (hard and soft acid base theory) - methods of determination and the study of reaction mechanisms. SN_1, SN_2, SN_i and neighbouring group mechanisms - kinetics - effects of structure - solvent and leaving and entering group - stereochemistry - hydrolysis of esters - Wurtz reaction - Claisen and Dieckmann condensation - Williamson reactions. Different mechanisms of aromatic nucleophilic substitution - Ziegler alkylation - Chichibabin reaction - Cine substitution - diazonium group as leaving group.

UNIT-II: ALIPHATIC AND AROMATIC ELECTROPHILIC SUBSTITUTION REACTIONS

SE_1 and SE_2 reactions - mechanisms and reactivity - typical reactions involving migration of double bond - keto-enol tautomerism - halogenation of carbonyl compounds - Stork enamine reactions - decarboxylation of aliphatic acids - Friedel Crafts acylation of olefinic carbon. Aromatic electrophilic substitution - reactivity - orientation and mechanisms - nitration - halogenation and sulphonation - Friedel Crafts alkylation - Friedel Crafts arylation (Scholl reaction) and acylation - Jacobsen reaction - formylation with (i) disubstituted formamides(Vilsmeyer- Haack reaction) (ii) zinc cyanide and HCl (Gattermann reaction) (iii) chloroform (Reimer - Tiemann reaction) - carboxylation with (i) carbonyl halides (ii) carbon dioxide (Kolbe Schmidt reaction) - amidation with isocyanates - hydroxyalkylation (hydroxyalkyl - dehydrogenation)- cyanodehydration of aldehydes and ketones (Bradsher reaction and Bischer - Napieralski rection) - haloalkylation - aminoalkylation and amido alkylation - thioalkylation -acylation with nitriles (Hoesch reaction) - cyanation - hydroxylation.

UNIT-III: MOLECULAR REARRANGEMENTS

Molecular rearrangements - intramolecular rearrangements - 1,2- shifts in carbonium ions - Wagner-Meerwin and related rearrangements - Demjanov rearrangement - migration to carbonyl carbon - Neber rearrangement –Benzilic acid- Baeyer-Villeger rearrangement - rearrangements to electron deficient nitrogen and oxygen - dienone-phenone - Favorski - Wolf - benzidine - Claisen - Cope rearrangement, Ylides:Stevens-Wittig-Sommelet-Gruvenstein-Zimmermann rearrangements- non-cyclic rearrangements - Chapman - Wallach rearrangement.

UNIT-IV: ADDITION AND ELIMINATION REACTIONS

Addition to C-C and C-O multiple bonds - electrophilic, nucleophilic and free-radical additions - additions to conjucated systems - orientation - Birch reduction - hydroboration - Michael condensation - 1,3 dipolar additions - Diels-Alder reactions - carbene addition to double bonds - hydration of olefines. Mannich reaction - Meerwein-Pondorf reduction - Grignard reactions - Aldol - Claisen - Stobbe - Darsen - Wittig - Thorpe and benzoin condensations - Cannizarro reaction.Elimination reactions - E1 and E2 mechanisms - orientations - Hofmann and Saytzeff rules - elimination versus substitution - Chaugav reaction - Hofmann degradation and Cope elimination - dehydration of alcohols - dehydrohalogenation - mechanisms and orientation in pyrolytic elimination.

UNIT-V: OXIDATION AND REDUCTION

Formation of C=C, C-C bonds by dehydrogenation - dehydrogenation by quinones, SeO_2, $Hg(OAc)_2$, and Pb(OAc) - formation of C-C bond in phenol coupling - acetylene coupling - allylic oxidation - oxidation of alcohols, glycols, halides and amines to aldehydes and ketones - ozonolysis - oxidation of olefinic double bonds and unsaturated carbonyl compounds - oxidative cleavage of the C-C bond - Sommelet reaction and selectivity in reduction - metal hydride reduction- metal alkoxide reduction - reduction by dissolving metals - Clemmensen reduction - Wolf Kishner reduction - metal ammonia

reduction (Birch reduction) - reduction of nitro compounds - acyloin condensation - catinanes.Carbenes and nitrenes - structure and generation - addition reaction with alkenes - insertion reactions.

References

1. Jerry March, Advanced organic chemistry - Reactions, mechanism and structure, Mc Graw Hill Kogakusha Ltd., 1977.
2. Lowry and Richardson, Mechanism and theory in organic chemistry, Harper & Row Publishers, New York 1981.
3. Mukergee and S. P. Singh, Reactions mechanisms in organic chemistry, Mc Millan 1976.
4. Raj K.Bansal Organic Chemistry Reaction mechanisms,Mc.Graw-Hill Publishing Company Ltd,2006

13B (B) BIOCHEMISTRY

UNIT-I

Structure of atoms, molecules and chemical bonds; Classes of organic compounds and functional groups. Covalent and Noncovalent interactions - Van der Waals, Electrostatic, Hydrogen bonding and hydrophobic interactions,Thermodynamics, kinetics, dissociation and association constants: Enzymes and coenzymes; Respiration and photosynthesis. Chemical foundations of Biology- pH, pK, acids, bases and buffers, Henderson – Hasselbach equation, biological buffer solutions. Energy metabolism (concept of free energy); Principles of thermodynamics; energy rich bonds; weak interactions; coupled reactions and oxidative phosphorylation; group transfer; biological energy transducers; bioenergetics.

UNIT-II

Sugars - classification and reactions. Polysaccharides: classification, occurrence, isolation, purification, properties and biological reactions. Structural features of homoglycans, heteroglycans and complex carbohydrates.Methods for compositional analysis. *Proteins:* Amino acids and peptides-classification, chemical reactions and physical properties. Peptide bond, Primary structure of proteins, structural comparison at secondary and tertiary levels (Ramchandran map), conformation of proteins and polypeptides (secondary, tertiary, quaternary and domain structure),Purification and criteria of homogeneity:protein folding-biophysical and cellular aspects.

Lipids: Classification, structure and functions. Triglycerides; Phospholipids; Steroids and terpenes. Glyco and lipoproteins-structure and function. Role of lipids in biomembranes. *Nucleic acids:* Structure of double stranded DNA (B, A, C, D, T and Z DNA). The biological significance of double strandedness, sequence dependent variation in the shape of DNA. Physical properties of double stranded DNA Types of RNAs and their biological significance. DNA bending, DNA supercoiling. Conformational properties of polynucleotides, secondary and tertiary structural features and their analysis.

UNIT-III

Enzyme kinetics (negative and positive cooperativity); Regulation of enzymatic activity; Enzyme catalysis in solution. kinetics and thermodynamic analysis, effects of organic solvents on enzyme catalysis and structural consequences. Active sites; Coenzymes: activators and inhibitors, kinetics of enzyme inhibitors, isoenymes, allosteric enzymes; Ribozyme, hammer head, hair pin and other ribozymes, strategies for designing ribozymes. Abzyme: structure and drug targets (enzymes and receptors); Prodrug delivery using enzymes; Bioluminescence

UNIT-IV

Silk fibroin, coiled coils, collagen triple helix and hemoglobin. Denaturation and renaturation of proteins. Lysozyme- structure, enzymic activity, mechanism of lysozyme action. Analytical techniques: separation techniques, small and macro biomolecules, Protein- Protein and protein-ligand interactions. Physical and chemical methods for immobilization of small and macro molecules.

UNIT-V

Glycolysis and TCA cycle; Glycogen breakdown and synthesis; Gluconogenesis; interconversion of hexoses and pentoses: Co-ordinated control of metabolism; Biosynthesis of purines and pyrimidines; Oxidation of lipids; Biosynthesis of fatty acids; Triglycerides; Phospholipids; Sterols.

References

1. Biochemistry, Christopher K. Mathews, Kensal E. van Holde, Kevin G. Ahern, 3rd Edition, Pearson Education, 2000.
2. Principles of Biochemistry, Abraham White, Philip Handler, Emil L. Smith., McGraw – Hill International book Company, 8th Edition, 1973.
3. Principles of Biochemistry, Lehninger , Nelson, Cox, CBS publishers and distributors, New Delhi, 2004.
4. Fundamentals of Biochemistry, Donald Voet, Akif Uzman, Judith G. Voet, Charlotte W. Pratt, John Wiley and Sons, New York, 2008.
5. Biochemistry, Geoffrey L. Zubay , WCB publishers, 1998.
6. Harper's Biochemistry, R.K.Murray, D.K.Granner, P.A.Mayes and V.W Rodwell,24th edition, Stamford, 1996.
7. Biochemistry – Lubert Stryer, 1995.

13C (P) QUANTUM MECHANICS

UNIT-I: GENERAL FORMALISM OF QUANTUM MECHANICS

Linear Vector Space- Linear Operator- Eigen Functions and Eigen Values- Hermitian Operator- Postulates of Quantum Mechanics- Simultaneous Measurability of Observables- General Uncertainty Relation- Dirac's Notation- Equations of Motion; Schrodinger, Heisenberg and Dirac representation- momentum representation.

UNIT-II: ENERGY EIGEN VALUE PROBLEMS

Particle in a box – Linear Harmonic oscillator- Tunnelling through a barrier- particle moving in a spherically symmetric potential- System of two interacting particles-Rigid rotator- Hydrogen atom

UNIT-III: ANGULAR MOMENTUM

Orbital Angular Momentum-Spin Angular Momentum-Total Angular Momentum Operators-Commutation Relations of Total Angular Momentum with Components-Ladder operators-Commutation Relation of Jz with J+ and J- - Eigen values of J2, Jz-Matrix representation of J2, Jz, J+ and J- - Addition of angular momenta- Clebsch Gordon Coefficients – Properties.

UNIT-IV: APPROXIMATE METHODS

Time Independent Perturbation Theory in Non-Degenerate Case-Ground State of Helium Atom-Degenerate Case-Stark Effect in Hydrogen – Spin-orbit interaction-Variation Method & its Application to Hydrogen Molecule- WKB Approximation.

UNIT-V: MANY ELECTRON ATOMS

Indistinguishable particles – Pauli principle- Inclusion of spin – spin functions for two-electrons- The Helium Atom – Central Field Approximation - Thomas-Fermi model of the Atom - Hartree Equation- Hartree -Fock equation.

Books for Study and Reference:

1. A Text Book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, Tata McGraw Hill, 2010.
2. Quantum Mechanics, G. Aruldhas, Prentice Hall of India, 2006.
3. Introduction to Quantum Mechanics, David J.Griffiths, Pearson Prentice Hall, New Delhi, 2005.
4. Quantum Mechanics, L.I Schiff, McGraw-Hill, 1968.
5. Quantum Mechanics, A. Devanathan, Narosa Publishing, New Delhi, 2005.
6. Principles of Quantum Mechanics, R.Shankar, Springer, 2005

Tutorial: (This portion is not intended for examination purpose)

1. Plotting of harmonic oscillator wave functions
2. Problems involving matrix representations of an operator
3. Alpha emission
4. Kronig-Penney Square-well periodic Potential

13C (C) INORGANIC CHEMISTRY

UNIT-I

18 electron rule - EAN rule - theories of coordination compounds - valence bond theory - crystal field theory - splitting of d orbitals in different symmetries - crystal field stabilisation energy - factors affecting the magnitude of 10 Dq - evidence for crystal field stabilisation - spectrochemical series - site selection in spinels - tetragonal distortion from octahedral symmetry - Jahn-Teller distortion - molecular orbital theory - octahedral complexes - tetrahedral and square planar complexes - pi bonding and molecular orbital theory - experimental evidence for pi bonding.

UNIT-II

Term states of d^n ions - electronic spectra of coordination compounds - selection rules - band intensities and band widths - energy level diagrams of Orgel and Tanabe - Sugano - spectra of Ti^{3+}, V^{3+}, Ni^{2+}, Cr^{3+}, Co^{2+}, Cr^{2+} and Fe^{2+} - calculation of 10Dq and B for V^{3+}(oct) and Ni^{2+}(oct) complexes. Magnetic properties of coordination compounds - change in magnetic properties of complexes in terms of spin orbit coupling - temperature independent paramagnetism - spin cross over phenomena.

UNIT-III

Substitution reactions in square planar complexes - the rate law for nucleophilic substitution in a square planar complex - the trans effect - theories of trans effect - mechanism of nucleophilic substitution in square planar complexes - kinetics of octahedral substitution - ligand fields effects and reaction rates - mechanism of substitution in octahedral complexes - reaction rates influenced by acid and bases - racemisation and isomerisation - mechanisms of redox reactions - outer sphere mechanisms - excited state outer sphere electron transfer reactions - inner sphere mechanisms - mixed valent complexes.

UNIT-IV

Structure of coordination compounds with reference to the existence of various coordination numbers - complexes with coordination number two - complexes with coordiantion number three - complexes with coordiantion number four - tetrahedral and square planar complexes - complexes with coordination number five - regular trigonal bipyramidal and square pyramidal - site preference in trigonal bipyramidal complexes - site preference in square planar complexes - isomerism in five coordinate complexes - coordination number six - distortion from perfect octahedral symmerty - trigonal prism - geometrical isomerism in octahedral complexes - optical isomerism in octahedral complexes - absolute configuration of complexes - stereoselectivity and conformation of chelate rings - coordination number seven and eight.

UNIT-V

Inorganic chains - rings - cages and clusters - catenation - heterocatenation - intercalation chemistry - one dimensional conductor - isopoly anions - heteropoly anions - borazines -

phosphazenes - phosphazene polymers - ring compounds of sulphur and nitrogen - homocyclic inorganic systems - cages - boron cage compounds - metal clusters - dinuclear clusters - trinuclear clusters - tetranuclear clusters - hexanuclear clusters - structural prediction of organometallic clusters.

References

1. Inorganic Chemistry - Principles of structure and reactivity, Fourth Edition J. E. Huheey, E. A. Keiter and R. L. Keiter - Addition Wesley Publishing Co, NY, 1993.
2. Advanced Inorganic Chemistry - F. A. Cotton and G. Wilkinson
3. Mechanism of Inorganic reactions - F. Basolo and R. G. Pearson

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13C (B) MOLECULAR GENETICS

UNIT-I

Genome Organization in prokaryotes: genome of bacteria, bacteriophage and viruses, plasmids. The fine structure of a prokaryote gene; Genetics of bacteria: transformation, conjugation, transduction; the genetic map of *E.coli* genetic recombination. Genetics of viruses: Life cycle of virulent bacteriophages, temperate phages and prophage; genetic recombination in phages; mapping genes in phage lambda; The RNA phages, tumor viruses and cancer; viroids.

UNIT-II

Genome Organization in Eukaryotes, variation in chromosome number: haploidy, polyploidy, aneuploidy. Variation in chromosome structure: deficiency of deletion, duplication, translocation, inversion and B-chromosome. The fine structure of Eukaryote gene; Allele, Multiple allele, complementation test,pseudo alleles, Genetic mapping: Molecular marker,somatic cell hybrids, split genes, overlapping genes; transposons. Linkage and crossing over; The three point cross; double crossing over, cytological basis of crossing over; sex linkage; recombination in Neurospora.

UNIT-III

Principles of Mendelian inheritance; Mendel's experiments-monohybrid, dihybrid, trihybrid and multihybrid crosses. Interaction of genes: incomplete dominance, codominance, epistasis, complementary genes, duplicate genes, polymeric genes, modifying genes; Pleotrophy, genome imprinting, inheritance and lethal genes. Environment and gene expression: penetrance and expressivity; temperature, light, phenocopies. Quantitative or polygenic inheritance: Inheritance of kernel color in wheat; corolla length in tobacco, skin color inheritance in man, transgressive and regressive variation. Multiple alleles; Sex determination; Extra chromosomal inheritance.(Episome, mitochondria and chloroplast)

UNIT-IV

Human Genetics: Introduction to Human Genetics. Human Chromosomes: Structure and organization of DNA; Normal human karyotype: Paris Nomenclature; Chromosomal aberration: Numerical: Aneuploidy, Polyploidy (Eg: Turner, Down & Klinefelter Syndromes). Structural: Translocation, Duplication, Inversion, Ring Chromosome and Deletion (Eg: Cri-du-chat syndrome). Others: Mosaic, Chimera [Individual with two cell lines] Mendelian Traits: Straight hair, Curly hair, Blue and Brown colour of the eyes, Rolling of the tongue, attached and free ear lobes and Hypertrichosis.

UNIT-V

Clinical genetics: Genetic Diseases and Inheritance Pattern: Autosomal inheritance – Dominant (Eg: Adult polycystic kidney, Achondroplasia & eurofibromatosis.); Autosomal inheritance – Recessive (Eg: Albinism, Sickle Cell Anemia, Phenyl Ketonuria); X-linked : Recessive (Eg: Duchenne muscular dystrophy – DMD); X-linked : Dominant (Eg. **Xg** blood group); Y-linked inheritance (Holandric – Eg. Testes determining factor); Multifactorial inheritance (Eg: Congenital malformations – Cleft lip & palate, Rheumatoid arthritis and Diabetes. Pedigree studies: Symbols used in pedigree analysis. Pedigree analysis of important genetic diseases like Haemophilia, Color blindness, Duchenne Muscular Dystrophy (DMD). How normal genes work; Mechanism of disease. Diagnosis of disease: cytogenetics; Molecular cytogenetics, molecular genetics; cancer genetics. Prevention of disease: Prenatal diagnosis; Genetic counseling, Mutation:DNA damage and repair - chromosome aberration - transposons, sex linked inheritance and genetic disorders, somatic cell genetics, polygenetic inheritance and heritability.

References

1. The science of Genetics, Alan G. Atherly, Jack. R. Girton, Jhon. F. Mc Donald, Sounders college publishers, 1999.
2. Genes VII, Benjamin Lewin, Oxford University Press, 2000.
3. A primer of population genetics, Hartl. D.L, 3rd edition, Sinauer associates inc. Sunderland, 2000.
4. Molecular cell Biology, Darnell, Lodish, Baltimore, Scientific American Books, 1994.
5. Molecular and cellular Biology, Stephen L.Wolfe, Wadsworth Publishing Company, 1993.
6. Human genetics, A.Gardner, R.T.Howell and T.Davies, Vinod Vasishtha for Viva Books private limited, 2008. Published by arrangement with Scion publishing limited Mloxham Mill, Baraford Road, Bloxham Ox25 4FF, UK.

13D (P) MATHEMATICAL PHYSICS

UNIT-I: MATRICES AND DETERMINANTS

Properties of matrix addition and multiplication – different types of matrices and their properties – Rank of a Matrix and some of its theorems – solutions to linear homogeneous and non homogeneous equations – Cramers rule - eigenvalues and eigenvectors of matrices – differentiation and integration of a matrix

UNIT-II: SOLVING OF DIFFERENTIAL EQUATIONS

Homogeneous linear equations of second order with constant coefficients and their solutions – ordinary second order differential with variable coefficients and their solution by power series and Frobenius methods - extended power series method for indicial equations

UNIT-III: SPECIAL DIFFERENTIAL EQUATIONS AND THEIR SOLUTIONS

Legendre's differential equation: Legendre polynomials - Generating functions – Recurrence Formulae – Rodriques's formula – orthogonality of Legendre's polynomial; Bessel's differential equation: Bessel's polynomial - generating functions – Recurrence Formulae – orthogonal properties of Bessel's polynomials – Hermite differential equation – Hermite polynomials – generating functions – recurrence relation.

UNIT-IV: LAPLACE TRANSFORMS

Laplace transforms: Linearity property, first and second translation property of LT – Derivatives of Laplace transforms – Laplace transform of integrals – Initial and Final value theorems; Methods for finding LT: direct and series expansion method, Method of differential equation; Inverse Laplace transforms: Linearity property, first and second translation property, Convolution property – Application of LT to differential equations and boundary value problems

UNIT-V: FOURIER SERIES AND INTEGRALS

Fourier series definition and expansion of a function – Drichlet's conditions – Assumptions for the validity of Fourier's series expansion and its theorems – Complex representation of Fourier series - Problems related to periodic functions – graphical representation of FS – Fourier integrals - convergence of FS – some applications of Fourier transforms

Text and Reference books:-

1. Mathematical Physics, B. D. Gupta, 3rd Edition, Vikas Publishing House PVT.LTD, 2006.
2. Mathematical Physics, B.S. Rajput, 17th Edition, Pragati Prakasam, 2004.
3. Advanced Engineering mathematics, Erwin Kreyszig, 7th Edition, Wiley Eastern Limited Publications, 1993.
4. Mathematical methods for physics, G. Arfken, 4th edition, 1992.
5. Special Function, W. W. Bell, 1996.

Books for Study and Reference

1. Mathematical Physics, B. D. Gupta, 3rd Edition, Vikas Publishing House PVT.LTD, 2006
2. Topics in Mathematical Physics, H. Parthasarathy, Ane Books Pvt. Ltd, 2007
3. Mathematical methods for physics, G. Arfken, 6th edition, Elsevier, 2010.
4. Mathematical Physics, B.S. Rajput, 17th Edition, Pragati Prakasam, 2004.
5. Advanced Engineering mathematics, Erwin Kreyszig, 7th Edition, Wiley Eastern Limited Publications, 1993.
6. Special Function for scientist and engineers, W.W.Bell, D. Van Nostrand Company Ltd, London,1968.

Tutorial: Mathematical Physics (This portion is not intended for examination purpose)

1. Fourier Transformation (FT) of Gaussian functions.
2. Applications of FT of dirac delta function.
3. Solution of time dependent problems by FT.

13D (C) PHYSICAL CHEMISTRY - I

UNIT-I: CHEMICAL KINETICS

Rates of chemical reaction, kinetics of first, second and third order reactions, complex methods of determining rate laws, order and molecularity concepts. Theories of reaction rates Arrhenius theory, hard-sphere collision theory of gas phase reactions. Potential energy surfaces. Activated complex theory for ideal gas reactions (formation in terms of partition functions). Relation between activated complex theory and hardsphere collision theory. Thermodynamic formulation-activated complex theory (Enthalpies and entropies of activation). Kinetic isotopic effect.

UNIT-II: REACTION IN SOLUTION

Comparison between gas phase and solution reactions. Cage effect. The influence of the solvent on the reactions between ions and reaction between ions and neutral molecules. Influence of ionic strength on rates of reactions in solution. Significance of volume and entropy of activation. Secondary salt effect. Kinetic treatment of complex ion. Parallel reactions of the same order (first or second, parallel first and second order reactions. Reversible reaction of the same order (first or second order). First order forward and second order backward. Consecutive first order reactions, steady state and rate determining step (or equilibrium) approximation of complex reactions. Chain reactions and explosions.

UNIT-III: HOMOGENEOUS CATALYSTS

Specific and general acid-base catalysis. Bronsted catalysis law. Acidity functions. Enzyme catalysis (single substrate reactions only). Michaelis-Menton kinetics. Influence of PH and temperature on enzyme catalysis. Surface Phenomenon and Heterogeneous catalysts Adsorption and free energy relation at interfaces. Gibb‘s adsorption isotherm. Physisorption and chemisorption. Adsorption isotherms (Langmuir and BET).

Measurement of surface area. Kinetics of heterogeneous catalysis (Langmuir hinshelwood mechanism and Eley-Rideal mechanism). Semi conductor catalysis.

UNIT-IV: MACROMOLECULES

Addition and condensation polymers, number average and weight average molecular weights of macromolecules. Determination of molecular weights. Kinetics of polymerization, molecular and free radical mechanism. Polymerisation in solution. Stereochemistry.

UNIT-V: FAST REACTIONS

Study by stop-flow techniques, relaxation methods. Flash photolysis, magnetic resonance methods. Kinetic theory of gases Postulates – Maxwell distribution of Molecular velocities- Expressions for most probable velocity, average velocity, root mean square velocity . Collision diameter, Collision frequency, Mean free path. Transport properties of gases – Thermal conductivity, Viscosity, Diffusion - principle of equipartition of energy.

References

1. K.J. Laidler, Chemical Kinetics, Tata McGraw Hill
2. Gurdeep Raj, Chemical Kinetics, Goel Publishing House.
3. P.W.Atkins, Physical Chemistry
4. W.J.Moore, Physical Chemistry, Longmans
5. A.A.Frost and R.G.Pearson, Kinetics and Mechanism, Wiley Eastern, Pvt. Ltd.
6. F.W. Billmeyer, Text book of Polymer science, Wiley- Interscience.

13D (B) CELL AND MOLECULAR BIOLOGY

UNIT-I

Structure and function of cells in prokaryotes and eukaryotes; Structure and organization of Membrane - Model membranes, Glyco conjugates and proteins in membrane systems; Response to stress - active and passive, transport channels and pumps, Neurotransmission, neuromuscular junction. Extra cellular matrix – cell to cell and cell matrix adhesion – selectins, Integrins, cadherins, gap junctions.

UNIT-II

Mitochondria – structure, biogenesis; Chloroplast – structure, biogenesis; Molecular events of electron transport chain, ATP synthesis, photosynthesis and photorespiration. Structure of Endoplasmic reticulum, Golgi complex, lysosomes; protein synthesis and post translational modification; of proteins vesicular transport and import into cell organelles

UNIT-III

Oxidative reactions in microbodies, Nucleus,. The nucleosome, the supranucleosomal structures;. Nucleic acid structure: DNA and RNA; DNA replication; transcription and translation. Gene regulation: prokaryotic gene regulation- Operon concept; lac operon and tryptophan operon; Eukaryotic gene regulation: transcriptional and translational regulations.

UNIT-IV

Mechanism of cell division: regulation of cell cycle; factors and genes regulating cell cycle. Cell signaling – types of cell signaling - G protein mediated, Tyrosine kinase mediated signaling. Biochemistry and molecular biology of Cancer, tumour suppressor and oncogenes;

UNIT-V

Cellular signaling; cell differentiation; gametogenesis and fertilization;life cycle and molecular biology of some pathogens – AIDS virus, tuberculosis, malarial parasite, hepatitis virus, filarial parasite and kalazar parasite

Techniques (Self Study)

Radiolabeling techniques: Properties of different types of radioisotopes normally used in biology, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

References

1. Molecular cell Biology, Darnell, Lodish, Baltimore, Scientific American Books, Inc., 1994.
2. Molecular and cellular Biology, Stephen L.Wolfe, Wadsworth Publishing company, 1993.
3. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
4. Introduction to Practical Molecular Biology, P.D.Dabre, John Wiley & Sons Ltd., New York, 1998.
5. Molecular Biology LabFax, T.A. Brown, Bios Scientific Publishers Ltd., Oxford, 1991.
6. Molecular Biology of the Gene, J.D.Watson, N.H.Hopkins, J.W.Roberts, J.A. Steitz and A.M.Weiner, 4th Edition, The Benjamin/Cummings Pub. Co., Inc., California,1987.
7. Genes VI, Benjamin Lewin, 6th Edition, Oxford University Press, U.K., 1998

1EA ELECTRONICS

UNIT-I: OPERATIONAL AMPLIFIERS

The ideal Op-Amp-inverting, non-inverting and differential amplifiers-CMRR; Op-Amp IC building blocks-emitter coupled differential amplifier, active load, level shifting and output stage; Op-Amp characteristics-open-loop input output characteristics, frequency response and slew rate; Op-Amp applications-adder, subtractor, integrator, differentiator, comparator, voltage-to-current converter, current-to-voltage converter and logarithmic amplifier.

UNIT-II: DIGITAL ELECTRONICS

Logic gates-Boolean algebra and De-Morgan's theorem; Boolean laws and theorem-Sum-of-Products and Products-of-Sums method-Karnaugh simplifications; Multiplexers and Demultiplexers; BCD-to-Decimal decoders-Seven-segment decoders; Decimal-to-BCD encoder; Half-adder and Full-adder circuits.

UNIT-III: FLIP-FLOPS

Types of Flip-Flops-RS Flip-Flop, Clocked RS Flip-Flop, D Flip-Flop , J-K Flip-Flop and J-K Master-Slave Flip-Flops; Schmit Trigger; 555 Timer-Astable and Monostable circuits.

UNIT-IV: REGISTERS AND COUNTERS

Types of Registers-Serial in-Serial out, Serial in-Parallel out, Parallel in-Serial out, Parallel in-Parallel out Registers; Types of Counters-Ring Counters, Asynchronous and Synchronous Counters, Shift Counters; D/A and A/D Converters.

UNIT-V: MOLECULAR ELECTRONICS

Molecular Scale Electronics – Introduction – Nanosystems – Engineering Materials At the Molecular Level - Molecular Device Architectures – Molecular Rectification – Electronic Switching and Memory Devices – Single Electronic Devices – Optical and Chemical Switches – Nanomagnetic Systems – Nanotube Electronics – Molecular Actuation – Logic Circuits – Computing Architectures – Quantum Computing.

Books for Study and Reference:

1. Text Book of Electronics, S. Chattopadhyay, New Central Book Agency P.Ltd., Kolkata, 2006.
2. Digital Principles and Applications, A.P. Malvino and D.P. Leach, Tata McGraw-Hill, Publishing Co., New Delhi, 1986.
3. Molecular Electronics From Principle to Practice, Michael C. Petty, John Wiley & Sons. Ltd., 2007.

4. Electronics Principles, Malvino, 6th Edition, Tata McGraw-Hill Publishing Co., New Delhi, 2001.
5. Electronics Principles and Applications, A.B. Bhattacharya, New Central Book Agency P.Ltd., Kolkata, 2007.

Tutorials

1. Suppose a three-variable truth table has a high output for these input conditions: 000, 010, 100 and 110. What is the sum-of-products circuit?
2. A truth table has low outputs for inputs of 0000 to 0110, a high output for 0111, low outputs for 1000 to 1001, don't cares for 1010 to 1111. Show the simplest logic circuit for this truth table.
3. Suppose a truth table has a low output for the first three input conditions: 000, 001 and 010. If all other outputs are high, what is the product-of-sums circuit?
4. A sine wave with a peak of 6 V drives one of the inverters in a 7414. Sketch the output voltage.
5. Examine the logic levels at the input of a 54/74L91 and show how a 1 and then a 0 are shifted into the register.

1EA ANALYTICAL CHEMISTRY

UNIT-I: STATISTICAL TESTS AND ERROR ANALYSIS

Accuracy, precision, classification of errors, minimisation of errors, significant figures and computation, mean deviation and standard deviation, Gaussian distribution, mean value statistics.**Sampling and sample treatment:** Factors involved in effective sampling, good samples; representative and homogeneous; the binomial distribution, samples of mixtures, physical separations in sample preparation, preconcentration and predilution.

UNIT-II: GRAVIMETRIC ANALYSIS

Theory of gravimetric analysis: introduction, solubility, solubility product, common ion effect, precipitation methods, the colloidal state, super-saturation, precipitate formation, co-precipitation, condition of precipitation, precipitation from homogeneous solution, purity of precipitates. Washing of precipitates, ignition of precipitates, thermogravimetric analysis, contamination of precipitates. **Titrimetric Analysis: Acid-base titrations:** Classification, theory of acid-base titrations, neutralisation indicators, mixed indicators, universal indicators, neutralisation curves, choice of indicators in neutralisation reactions.

UNIT-III: COMPLEXOMETRIC TITRATIONS

Stability of complexes, factors influencing the stability of complexes, stability constants of EDTA complexes, titration curves, selectivity, masking and demasking agents, metal ion indicators.**Precipitation titrations**: Theory of precipitation reactions, determination of end points in precipitation reactions.**Oxidation - reduction titrations:** Theory, change of electrode potential during the titration of a reductant with an oxidant, formal potentials, detection of end points in oxidation-reduction titrations, titrations in non-aqueous media.

UNIT-IV: ELECTROANALYTICAL METHODS

Theory of electrogravimetric analysis, electrode reactions, overpotential, completeness of deposition, electrolytic separation of metals with controlled cathode potential. **Potentiometry:** Reference electrodes, indicator electrodes, ion-selective electrodes, instrumentation and measurement of cell emf, potentiometric titrations.**Voltammetry**:Current-voltage relationship, characteristic of DME, half-wave potential. Amperometric titrations, biamperometric titrations, determination of water using Karl Fischer reagent.

UNIT-V: FLAME SPECTROMETRY

Instrumentation, combustion flames, nebuliser burner system, resonance line sources, monochromator, detector, types of interferences, comparison, single beam AAS, double beam AAS nonflame techniques, cold vapour AAS. **Chromatographic methods:** Principles, classification, techniques of column chromatography, ion exchange chromatography, gas chromatography, high performance liquid chromatography, paper chromatography and thin layer chromatography. **Radioanalytical methods:** Introduction, activation analysis, isotope dilution analysis, radiometric titrations.

References

1. Analytical Chemistry, Gary D. Christian, 5th Edition, John-Wiley & Sons, Inc, 1994.
2. Principles of Instrumental Analysis, D. A. Skoog & D. M. West, Holt Reinhart Winston, 1988.
3. Chemical Analysis, K. A. Robinsons, Harper Collins Publishers, 1987.
4. Vogel's Text Book of quantitative Inorganic Analysis, J. Basset, R. C. Denny, C. H. Jaffery and J. Mendhan, 5th Edition, ELBS, 1989.
5. Instrumental methods of Analysis, H. A. Willard, L. L. Merrit, J. A. Dean, Van Nostrand, 1986.

1EA BIOSTATISTICS

UNIT-I

Descriptive statistics and relationship of quantitative variables: Tabulation of data and its graphical representation; Frequency distributions; Measures of central tendency (mean, median mode) and dispersion (range, MD, Variatrion, SD, cv); Probablity (permutation and combination); rank correlation coefficient, concurrent deviation methods, simple regression analysis.

UNIT-II

Theoretical probability distributions: Chi square Test; Probability distributions (Binomial, Poisson, Normal); Population (finite and infinite) and sampling (Methods); students 't' methods, analysis of frequencies and variance (F-test).

UNIT-III

Design of experiments: Completely randomized design, Randomised Block design; Latin square, factorial design; Central Composite Design (RSM and its applications)

UNIT-IV

Correlation and Regression: Types of correlation, Simple linear correlation and Multiple regression; Probit analysis; Muetrovariate statistics.

UNIT-V

Computers in Statistics: Microsoft excel for statistical functions (Chi-square test; t-test; ANOVA; Correlation and Regression) and Graphical representations; Software for statistics (IRRISTAT, SPSS, SYSTAT, Design Expert)

References

1. Biostatistical analysis, J.H.Zar, 4th Edition, Pearson Eduction Inc, 1999.
2. Biostatistics – How it works, Steve Selvin, Pearson Eduction Inc.
3. An introduction to Biostatistics, Glover and Mitchell, Mc Graw Hill, 2008.
4. Fundamentals of Biostatiostics –Practical approach, N.K.R.Dutta, Kanishka publishers, New Delhi, 2002.
5. An Introduction to Biostatistics, N.Gurumani, 2nd Edition, MJP publishers, Chennai
6. Statistical Methods, S.P.Gupta, Sultan Chand and Sons, 2003.
7. Biostatistics – A foundation for analysis in health Science, W. Daniel, Wiley, 1983.

13P PRACTICAL - I

1. Study the forward and reverse characteristics of a Zener diode.
2. Construction of adder, subtracter, differentiator and integrator circuits using the given OP – Amp.
3. Study the static and drain characteristics of a JFET.
4. Study the characteristics of UJT.
5. Construction of a single FET amplifier with Common Source configuration.
6. Qualitative analysis of simple organic compounds and two component mixtures.Organic estimations based on functional groups.
7. Analysis of two component and three component mixtures separation and characterization with emphasis on characterization by derivatives.
8. Preparation of simple organic compounds and their identification by spectroscopic methods.
9. Semimicro qualitative analysis of common cation and anion containing the following less familiar elements: Tl, W, Sc, Te, Mo, Ce, Th, Ti, Zr, V, Be, U, Li and Cs.
10. Simple inorganic preparations including some complex compounds.
11. Preparation and analysis of metal complexes, characterisation by spectroscopic, magnetic, thermal and x-ray diffraction methods.
12. Determination of protein by Lowry method using BSA
13. Enzyme assay determination of specific activity of enzyme.
14. Determination of molecular weight of a protein by SDS-PAGE
15. Seperation of peripheral mononuclear cells from the blood.
16. Haematology: RBC and WBC total counts

23A SYNTHESIS AND CHARACTERIZATION OF NANOMATERIALS

UNIT-I: PHYSICAL AND CHEMICAL METHODS

Ball Milling – Electrodeposition - Spray Pyrolysis - Flame Pyrolysis - Inert Gas Condensation Technique (IGCT) – Thermal evaporation – Pulsed Laser Deposition (PLD) – DC/RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE), Sol-Gel Process — Self assembly – Metal Nanocrystals by Reduction - Solvothermal Synthesis - Photochemical Synthesis - Sonochemical Routes – Reverse Micelles and Micro emulsions - Combustion Method – Template Process - Chemical Vapor Deposition (CVD) – Metal Oxide Chemical Vapor Deposition (MOCVD)

UNIT-II: BIOLOGICAL SYNTHESIS AND NANOCOMPOSITES

Introduction - Natural Nanocomposite Materials - Biologically Synthesized Nanoparticles, Nanostructures and Synthetic Nanocomposites - Protein-Based Nanostructure Formation - DNA-Templated Nanostructure Formation - Protein Assembly - Biologically Inspired Nanocomposites - Lyotropic Liquid-Crystal Templating - Liquid-Crystal Templating of Thin Films - Block-Copolymer Templating - Colloidal Templating.

Ceramic/Metal Nanocomposites - Metal Matrix Nanocomposites - Nanocomposites for Hard Coatings – Polymer based nanocomposites – nanoscale fillers – processing of polymer nanocomposites – Properties of polymer nanocomposites.

UNIT-III: CHARACTERIZATION METHODS- I

X-ray diffraction - Debye-Scherer formula – dislocation density – micro strain – Synchrotron Radiation – Principle and Applications –Raman Spectroscopy and its Applications – Dynamic Light Scattering (DLS). Electron microscopes: scanning electron microscope (SEM) – transmission electron microscope (TEM); atomic force microscope (AFM) – scanning tunneling microscope (STM) - XPS – Working Principle, Instrumentation and Applications.

UNIT-IV: CHARACTERIZATION METHODS- II

Impedance Analysis - Micro hardness - nanoindentation – vibrating sample magnetometer – Nuclear Magnetic Resonance (NMR). Differential scanning calorimeter (DSC) – Thermogravimetric/Diffferential Thermal Analyzer (TG/DTA) – UV – Visible Spectrophotometer - FTIR – Principle and Applications – Photoluminescence (PL) Spectroscopy.

UNIT-V:LITHOGRAPHIC METHODS

Introduction – Lithography – Photolithography - Phase-shifting photolithography - Electron beam lithography - X-ray lithography - Focused ion beam (FIB) lithography - Neutral atomic beam lithography - Nanomanipulation and Nanolithography - Soft Lithography - Assembly of Nanoparticles and Nanowires Other Methods for Microfabrication.

References

1. Recent Advances in the Liquid-phase syntheses if inorganic nanoparticles, Brain L.Cushing, Vladimir L.Kolesnichenko, Charles J. O'Connor, Chem Rev. 104 (2004) 3893-3946.
2. Nanocrystals: Synthesis, Properties and Applications, C. N. R. Rao, P. J. Thomas and G. U. Kulkarni, Springer (2007).
3. Nanotechnology - Enabled Sensors, Kourosh Kalantar-zadeh and Benjamin Fry, Springer (2008).
4. Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Guozhong Gao, Imperial College Press (2004).
5. Nanochemistry: A Chemical Approach to Nanomaterials – Royal Society of Chemistry, Cambridge, UK (2005).
6. Nanocomposite science and technology, Pulickel M.Ajayan, Linda S.Schadler, Paul V.Braun, Wiley-VCH Verlag, Weiheim (2003).
7. Encyclopedia of Materials Characterization, C. Richard Brundle, Charles A. Evans Jr., Shaun Wilson, Butterworth-Heinemann Publishers (1992).
8. Handbook of Microscopy for Nanotechnology, Ed. By Nan Yao and Zhong Lin Wang, Kluwer Academic Press (2005).
9. Nanochemistry, G. B. Sergeev, Elsevier (2006).
10. Nanotechnology: Basic Science and Emerging Technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press (2005).
11. Handbook of Analytical Techniques, Edited By Helmut Günzler and Alex Williams, Wiley VCH, 2002.

23B PROPERTIES OF NANOMATERIALS

UNIT-I: ELECTRICAL AND MECHANICAL PROPERTIES

Introduction - Energy Storage Basics - General Information: Electrical Energy Storage Devices and Impact of Nanomaterials – Batteries – Capacitors - Gold Standards (State of the Art) for Both Batteries and Capacitors - Electrochemical Properties of Nanoscale Materials - Aerogels and Structure-Directed Mesoporous and Macroporous Solids - Nanoparticles - Nanotubes, Nanowires, and Nanorolls.

Nanoscale Mechanics - Introduction – Mechanical properties – Density Considered as an Example Property – The Elasticity of Nanomaterials – Elasticity of Bulk Nanomaterials – Plastic Deformation of Nanomaterials - The Physical Basis of Yield Strength – Crystals and Crystal Plasticity – From Crystal Plasticity to Polycrystal Plasticity.

UNIT-II: NANOOPTICS

Absorption: direct and indirect bandgap transitions - Emission: photoluminescence and Raman Scattering - Emission: chemiluminescence and Electroluminescence - Shape dependent optical properties - Optical absorption - Optical emission - Surface plasmon resonance (SPR) - Surface enhanced Raman scattering (SERS)

UNIT-III: NANOCATALYSIS

Introduction – nanomaterials in catalysis – metals – recent progress – nanostructured adsorbant – metals – controlled pore size materials – pelletized nanocrystal – nanoparticles as new chemical reagents – metals – metal oxide reactions – nanocomposite polymers – fluids, inks and dyes – block co polymers and dendrimers – nanocrystal superlattices.

UNIT-IV: NANOMAGNETISM

Introduction – fundamental concepts – magnetic materials – dia, para and ferromagnetism - magnetic phenomena in ferromagnetic materials – magnetic anisotropy – magnetic domains – hysteresis small particle magnetism – single domain particles – coercivity of single domain particles – superparamagnetism – the coercivity of small particles - review of some issue in nanoscale magnetism.

UNIT-V: NANOELECTRONICS

Basics of nanoelectronics - Single electron transistor – Principle – Coulomb Blockade effect – performance of the single electron transistor – Bioelectronics – molecular processor – DNA analyzer as biochip – DNA computer – Quantum computer.

Reference

1. Nanomaterials : Mechanics and Mechanisms, K. T. Ramesh, Springer 2009.
2. Nanoscale materials in chemistry, Edited by Kenneth J. Klabunde, John Wiley & Sons, 2009.
3. Nanoscale materials in chemistry, Edited by Kenneth J. Klabunde, John Wiley & Sons, 2001.
4. Nanoscopic materials; Size dependent phenomena, Emil Roduner, RSC publishing, 2006.
5. Optical properties and spectroscopy of nanomaterials, Jin Zhong Zhang, World Scientific, 2009.
6. Nanoelectronics and nanosystems – K. Goser, P. Glösekötter and J. Dienstuhl, Springer 2008.

23C (P) STATISTICAL MECHANICS AND THERMODYNAMICS

UNIT-I:MICROCANONICAL, CANONICAL AND GRANDCANONICAL ENSEMBLES

Microcanonical distribution function – Two level system in microcanonical ensemble – Gibbs paradox and correct formula for entropy – The canonical distribution function – Contact with thermodynamics - Two level system in canonical ensemble – Partition function and free energy of an ideal gas – Distribution of molecular velocities – Equipartition and Virial theorems – The grand partition function – Relation between grandcanonical and canonical partition functions

UNIT-II: BOSE-EINSTEIN, FERMI-DIRAC AND MAXWELL-BOLTZMANN DISTRIBUTIONS

Bose-Einstein and Fermi-Dirac distributions – Thermodynamic quantities – Fluctuations in different ensembles – Bose and Fermi distributions in microcanonical ensemble - Maxwell-Boltzmann distribution law for microstates in a classical gas - Physical interpretation of the classical limit – Derivation of Boltzmann equation for change of states without and with collisions – Boltzmann equation for quantum statistics – Equilibrium distribution in Boltzmann equation

UNIT-III: BOSE GAS AND FERMI GAS

Non-interacting Bose gas and thermodynamic relations – Chemical potential of bosons – Density of states, pressure and energy density of bosons – Black body radiations and Planck's distribution law – Number density of photons and Bose condensation - Thermodynamic relations for non-interacting Fermi gas – Fermi gas at zero temperature – Fermi energy and Fermi momentum – Pressure and energy density – Fermi gas at low temperature – Energy density and heat capacity

UNIT-IV: HEAT CAPACITIES, ISING MODEL AND PHASE TRANSITIONS

Heat capacities of heteronuclear diatomic gas – Heat capacities of homonuclear diatomic gas – Heat capacities of solids; Dulong and petit law, Einstein temperature and Debye theory – Heat capcities of metals – Heat capacitiy of Bose gas – One-dimensional Ising model and its solution by variational method – Exact solution for one-dimensional Ising model – Bragg- Williams approximation for Ising model - Phase transitions and criterion for phase transitions – Classification of phase transitions by order and by symmetry – Phase diagrams for pure systems

UNIT–V: Thermodynamics, Microstates and Macrostates

Basic postulates of thermodynamics – Fundamental relations and definition of intensive variables – Intensive variables in the entropic formulation – Intensive variables in the entropic formulation - Equations of state – Euler relation, densities - Gibbs-Duhem relation for entropy - Thermodynamic potentials and extensivity properties – Maxwell relations – Energy differential and thermodynamic potentials of systems in external magnetic field - Thermodynamic relations – Microstates and macrostates – Ideal gas – Microstate and macrostate in classical systems – Microstate and macrostate in quantum systems – Density of states

Books for study and Reference

1. An Introductory Course of Statistical Mechanics, Palash B. Pal, Narosa Publishing House, New Delhi, 2008.
2. Elements of Statistical Mechanics, Kamal Singh & S.P. Singh, S. Chand & Company, New Delhi, 1992.
3. Statistical Mechanics an Elementary Outline, Avijit Lahiri, University Press, Hyderabad, 2002.

Tutorial: (This portion is not intended for examination)

1. Show explicitly that Gibbs paradox disappears when the correction is included.
2. Obtain free energy of linear harmonic oscillator through thermodynamic quantities
3. Derive Helmholtz free energy in terms of T, H and N.
4. Derive entropy, energy and heat capacity of a two level system when the temperature is zero and infinity.
5. Estimate the critical temperature for Bose condensation for ^{4}He atoms. Take g=1 and n=3X10^{22} cm^{-3}.

23C (C) ORGANIC CHEMISTRY - II

UNIT–I: TERPENOIDS

Isolation and classification - general methods to elucidate the structure of terpenoids - methods of structure elucidation and synthesis as applied to zingiberine - eudesmol - caryophyllene - abietic acid - santonin - biosynthesis of terpenes.

UNIT–II: AMINO ACIDS, PROTEINS AND NUCLEIC ACIDS

Synthesis of amino acids and polypeptides - primary and secondary structure of a protein - the N-terminal and C- terminal residue analysis - oxytocin - enzymes and coenzymes - biosynthesis of protein - nucleic acids - structure and synthesis of nucleosides - structure and synthesis of nucleotides -structure of RNA and DNA and their biological importance.

UNIT-III: CONFORMATIONAL ANALYSIS AND STEREOCHEMISTRY

Geometrical and optical isomers : R, S, E, Z configurational notations - different types of optical isomerism including dissymmetric over crowded molecules - stereochemistry of sulphur and nitrogen compounds - configurations - geometrical isomerism and configurations in mono and bicyclic ring systems - conformational analysis of acyclic system - cyclohexanes - perhydrophenantharene - decalins - carbohydrates - spiranes-allenes and biphenyls.Asymmetric Synthesis-Introduction-methods of asymmetric synthesis-auxillary controlled methods-reagent controlled methods-catalyst controlled methods.

UNIT-IV: VITAMINS

Structure and synthesis of vitamin B complex : vitamin B_1 (aneurin) - vitamin B_2 (riboflavin) - pantothenic acid - folic acid - vitamin H (biotin) - vitamin B_6 (pyridoxine) - vitamin B_{12} (cyanocobalamin) structure only - vitamin E (- tocopherol) - vitamin K_1 (phylloquinone) and vitamin K_2.

UNIT-V: HETEROCYCLIC COMPOUNDS

Structure - synthesis and reactions of the following systems - indole - quinoline - isoquinoline - carbazole - chromone - flavanones - flavones - flavonols - isoflavones - anthocyanins - purines - uric acid - penicillins and sulpha drugs.

References

1. I. L. Finar, Organic chemistry, vol. I and vol. II.
2. Nakanishi et. al., Natural product chemistry, vol. I, Academis press, 1974.
3. New Mann, Terpenes and Terpenoids.
4. E. L. Eliel, Stereochemistry of carbon compounds, Mc Graw Hill, 1962.
5. Acheson, Introduction to heterocyclic compounds.
6. P.Ramesh, Basic principles of Organic Stereochemistry,Meenu publication,2005.

23C(B) IMMUNOLOGY

UNIT-I

The Immune System: Innate Immune response and its role in protection. Adaptive Immune response, the humoral and cellular component of the Immune response, Overlap between Innate and adaptive immunity. Cells involved in the Immune response: Macrophages, B and T lymphocytes, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells. The lymphoid organs: Bone marrow, Spleen, lymph nodes, MALT. Haemopoiesis and differentiation, lymphocyte trafficking.

UNIT-II

The antigens seen by the Immune System: Antigenicity and Immunogenicity. The epitopes seen by B Cells and T Cells. Antibody Molecule: Structure of antibody molecules; Function of antibody molecules; Antibody-Antigen interactions; Generation of antibody diversity. Antibody engineering: Hybridoma secreting monoclonal antibodies-Recombinant antibody molecules. Catalytic Antibodies.

UNIT-III

Major Histocompatibility Complex: MHC molecules and organization of their genes; Structure and function of MHC gene products. Antigen Presentation: Antigen processing; Role of MHC and non-MHC molecules in antigen presentation. Structure of TCR and its interaction with MHC-I and MHC-II peptide Complex - T cell selection. Organization of TCR gene segments and their rearrangement. Activation of T-cells; Activation of TH and TC cells; Generation of T memory cells; Apoptosis in T cells. B-Cell maturation: Activation of B Cells; Regulation of BCell mediated effector functions.

UNIT-IV

Cytokines: structure of Cytokines; function of Cytokines. The Complement System. Cell mediated effector responses. Immune suppression and immune tolerance. Transplantation immunology- MLR, HLA Typing, Bone marrow transplantation, Organ transplants.

UNIT-V

Hypersensitivity reactions, Autoimmune disorders, Immunity to Infectious agents - Bacteria, Viruses, Malaria, Anthrax and Helminthes. Tumor immunology, Tumor antigens, immune response to tumors, cancer immunotherapy Vaccine technology and recombinant vaccines.

Techniques (Self Study):

Histochemical and immunotechniques: Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH.

References

1. Immunology, J.Kuby, 5th edition, W.H. Freeman and Company, New York, 2003.
2. An Introduction to Immunology, C.V.Rao, Narosa Publishing House, Chennai, 2002.
3. Challenge of AIDS, K.M.Pavri, National Book Trust, India, 1996.
4. Immunology: An Introduction , I.R.Tizard, 4th edition , Saunders College Publishers, New York, 1995
5. Essential Immunology, Blackwell Science, I.Roitt, Singapore, 1994.
6. Cellular and Molecular immunology, Abul K.Abbas, 1994.

23D (P) NUCLEAR AND PARTICLE PHYSICS

UNIT–I

Nuclear mass and binding energy - mass defect, mass excess, packing and binding fraction – Weizacker's formula based on liquid drop model – Application of semi empirical formula for alpha decay –mass parabola for stability of nuclei against beta decay – Fission process on the basis of liquid drop model – Energy released in fission process – Bohr-Wheeler's model for stability limits of heavy nuclei – Evidences for shell effects – Single particle energy levels for infinite square well, harmonic oscillator and spin-orbit potential – Application of shell model for nuclear spin, parity and magnetic moment

UNIT–II

Types of nuclear reaction – Conservation laws in nuclear reactions – Energetics of nuclear reactions – Threshold energy of reaction – Reaction induced by alpha particles (,p), (,n), (,) - Proton, deuteron and neutron induced reactions (p,), (p,n), (p,), (p,d), (d,), (d,p), (d,n),(d,), (d,t), (n,), (n,p), (n,d),(n,), (n,t) – Cross section of nuclear reaction – Partial wave method for nuclear scattering and reaction cross sections – Compound nucleus hypothesis – Breit-Wigner one level formula

UNIT–III

Ground state properties of deuteron – Square well solution of deuteron – Low energy neutron proton scattering – limits of energy for the scattering of different partial waves – Properties of nuclear force – Fine structure of alpha particles and long range alpha particles – Determination of velocities of alpha particles – alpha disintegration energy – WKB approximation for theory of alpha disintegration – Energetics of beta decay – Origin of continuous beta spectrum – neutrino hypothesis – properties of neutrino

UNIT–IV

Electrostatic generators – (Vandegraff, tandem, pelletron) – Cyclotron – Linear accelerators – Betatron – Ionization Chamber – Proportional counter – Geiger Muller Counter - Semi conductor detectors and its uses – Scintillation detector

UNIT–V

Classification of elementary particles – conservation laws – Isospin symmetry and SU(2) group –Symmetry classification of elementary particles – super multiplet of spin ½ baryons – supermultiplet of spin 0 mesons – meson resonance octet – baryon resonance decuplet – Quark hypothesis – quark structures of mesons and baryons

References

1. *Nuclear Physics,* S.N. Ghosal, S. Chand & Company Ltd, 1997.
2. *Nuclear Physics,* D.C. Tayal, Himalaya Publishing House, 1997.
3. *Nuclear Physics,* B.B. Srivastava, *Rastogi Publication.*
4. *Nuclear Physics,* S. B. Patel, New Age International Publisher, 1991.
5. Nuclear Physics, V. Devanathan, Alpha Science International, 2006.
6. *Introductory* Nuclear Physics, Kenneth S. Krane, Wiley, 1987.
7. *Nuclear Physics* theory and experiment, R. R. Roy, B.P. Nigam, Wiley, 1967.
8. *Concepts of Nuclear Physics,* Bernard L. Cohen, Tata McGraw-Hill, 1971.
9. *Nuclear Physics,* Irving Kaplan, Addision-Wesley Pub, 1963.
10. *Nuclear Physics,* John Lilley, Wiley, 2006.

23D (C) PHYSICAL CHEMISTRY - II

UNIT-I

Quantum chemistry: Failure of classical mechanics and the success of quantum theory in explaining black body radiation - heat capacities of solids - photoelectric effect and the H-atom spectrum - DeBroglie‘s matter waves - Heisenberg‘s uncertainty principle - Schrodinger equation - Born‘s interpretation of the wave function - requirements of the acceptable wave function. Algebra of operators - sums and products of operators - commutator - linear operators - eigen functions and eigen values - correspondence between physical quantities in classical mechanics and operators in quantum mechanics - Hamiltonian operator - quantisation of angular momentum and its spatial orientation - average (expectation) values - postulates of quantum mechanics.

UNIT-II

Particle in a one dimensional box - quantisation of energy - normalisation of wave function - orthogonality of the particle in a one-dimensional box wave functions - average position and average momentum of a particle in a one-dimensional box - illustration of the uncertainty principle and correspondence principle with reference to the particle in a one-dimensional box - particle in a three-dimensional box - separation of variables - degeneracy Solving of Schrodinger equation for the one dimensional harmonic oscillator - harmonic oscillator model of a diatomic molecule - illustration of the uncertainty principle and correspondence principle with reference to harmonic oscillator.

UNIT-III

Solving of Schrodinger equation for a rigid rotor - rigid rotor model of a diatomic molecule. Schrodinger equation for the H-atom (or H - like species) - separation of variables - energy levels - radial factors of the H-atom wave functions Electron spin and the Pauli principles - antisymmetric nature of the wave functions - Slater determinants - approximate wave function of many electron atoms. Need for approximation methods - the perturbation theory (first order only) application of the perturbation method of systems such as the anharmonic oscillator and He- atom – the variation method - applications of variation method to systems such as anharmonic oscillator and He-atom.

UNIT-IV

Electrochemistry - Ions in soluutions: Conductivity of solutions and their measurement - the Arrhenius ionisation theory - transport numbers and mobilities of ions - measurement of transport numbers - Hittorff method and moving boundary method - ionic activities and activity coefficients and their determination by various methods - Debye-Huckel-Onsager theory - ionic atmosphere - Debye-Huckel limiting law - acids and bases - dissociation constant of acids and bases.

UNIT - V

Electrochemical cells: Electromotive force - measurement of EMF - the potentiometer - the electrochemical potential - the cell EMF and the cell reaction - reversible cells - types of half cells - classification of cells - the standard EMF of a cell - standard electrode potentials - calculation of the EMF of a cell - Nernst equation and its limitations - calculation of solubility products - standard free energies and entropies of aqueous ions - electrode concentration cells - electrolyte concentration cells - cells with liquid junctions - oxidation - reduction reactions, measurement of PH, concentration cells with transference - electrolysis - decomposition voltages - concentration polarisation and over voltage - the polarograph.

References

1. I. N. Levine - Quantum chemistry, Prentice Hall of India Pvt Ltd, 1994.
2. R. K. Prasad - Quantum chemistry, Wiley Eastern Ltd, (1992).
3. W. J. Moore - Physical chemistry, (1962).

4. W. Castellan - Physical chemistry, (1971).
5. A. K. Chandra - Introductory quantum chemistry.
6. P. W. Atkins - Physical chemistry.
7. S. Glasstone - Electrochemistry.
8. Gordon M.Barrow-Physical Chemistry,Mc Graw Hill Publishing Company Ltd,2007.

23D (B) PHARMACEUTICAL BIOTECHNOLOGY

UNIT-I: BIOLOGICAL SYSTEMS AND MODELS

Routes of administration, adsorption enhancement / solubility factor/ bioavailability, site specific delivery; Pharmacodynamics of protein therapeutics; Inter species scaling; Chemical modification of proteins/ therapeutics; Colloidal particulate carrier system; Immuno suppressor in antibody therapy; High throughput screening; Automation; Combinatorial Synthesis: Chemistry, Biology, and Biotechnology; Genotyping: Genetic Pre-Disposition, and Heterogeneity; Pharmaco- Genomics.

UNIT-II: DRUG METABOLISM*:*

Oxidation, reduction, hydrolysis, conjugation. Need for developing new drugs: Procedure followed in drug design; Molecular modification of lead compounds; Prodrug and soft drugs; Physico-chemical parameters in drug design; QSAR; Active site determination of enzymes; Design of enzyme inhibitors.

UNIT-III: PHARMACOKINETICS &DRUG DISCOVERY

Substances derived from bacteria, plants, insects, and animals; Sources of active principles; Assay systems and models (e.g., Knock-out Mice) Protein molecular modeling by computer: Docking studies; Structure based drug designing using software (Insight II LS)

UNIT-IV: PLANTS AS PHARMACEUTICALS

Drugs derived from plants, natural resources of medicine, Antitumor agent - Etoposide, Colchicine, Demecolcine, Irinotecan, Lapachol, Taxol, Vinblastine, Vincristine. Cardiotonic – Convallatoxin, Acetyldigoxin, Adoniside, Antiinflammatory – Aescin, Bromelain, Local anaesthetic – Cocaine, Choleretic – Curcumin, Cynarin, Topical antifungal – Thymol, Antihypertensive, tranquilizer – Rescinnamine, Reserpine, Rhomitoxin.

UNIT-V: NANOPARTCLES IN DRUG DELIVERY.

Polymeric, Lipid nanoparticles for drug delivery, Micelles in Drug Delivery. Quantum Dots, Gold, silica, silver and magnetic nanoparticles for biomedical applications. Carbon nanotubes and their applications. Nanoparticulate Drug Delivery to the Reticuloendothelial System and to Associated Disorders – Delivery of Nanoparticles to the Cardiovascular System – Nanocarriers for the Vascular Delivery of Drugs to the Lungs – Nanoparticulate Carriers for Drug Delivery to the Brain – Nanoparticles for

Targeting Lymphatics – Polymeric Nanoparticles for Delivery in the Gastro-Intestinal Tract – Nanoparticular Carriers for Ocular Drug Delivery – Nanoparticles and Microparticles as Vaccines Adjuvants

References

1. Industrial Pharmaceutical Biotechnology, Heinrich Klefenz, Wiley-Vch Publication, Germany, 2002.
2. Pharmaceutical Biotechnology, Daan Crommelin, Robert D Sindelar, 2002, Tailor and Francis Publications, Newyork, 2002.
3. Hand book of Pharmaceutical Biotechnology, Jay P Rho, Stan G Louie, 2003, Pharmaceutical products press, Newyork, 2003
4. Theory and practice of industrial pharmacy, Lachman L Lieberman, HA, Kanig, J, 1986, 3rd edition, Varghese publishing & Co, New Delhi, 2000.
5. Remington's Pharamaceutial sciences, Joseph Price Remington , 18th edtion, Mack publishing & Co., Easton, 1980.
6. Nanoparticles as Drug carriers, Vladimir P Torchilin, Imperial College Press, USA, 2006
7. Nanomedicine, Parag Diwan and Ashish Bharadwaj, pentagon press, India, 2006.

2EB ADVANCED MATERIALS SCIENCE

UNIT-I:THEORY OF SEMICONDUCTORS

Intrinsic and extrinsic semiconductors - Free carrier concentration in semiconductors – Fermi level and carrier concentration in semiconductors – Mobility of charge carriers – Effect of temperature on mobility – electrical conductivity of semiconductors – Hall Effect in semiconductors – Junction properties.

UNIT-II: THEORY OF DIELECTRICS, PIEZOELECTRICS AND FERROELECTRICS

Dipole moment – Polarization – the electric field of a dipole – local electric field at an atom – Clausius –Mosotti equation - Dielectric constants and its measurements - Polarizability – The Classical theory of electronic polarizability – dipolar polarizability – Ferro electricity – Dipole theory of ferroelectricity – Piezoelectricity.

UNIT-III:MAGNETIC PROPERTIES OF MATERIALS

Terms and definitions used in magnetism – Classification of magnetic materials – theory of diamagnetism – Langevin theory of paramagnetism - Weiss theory – Paramagnetic susceptibility of a solid – Quantum theory of paramagnetism – Determination of susceptibility of para and dia magnetism using Gouy method - Ferromagnetism – Spontaneous magnetization in ferromagnetic materials – Quantum theory of ferromagnetism – Weiss Molecular field – Curie-Weiss law – Ferromagnetic domains – The Domain Model – Domain theory – Antiferromagnetism – Ferrimagnetism – Structure of Ferrite.

UNIT-IV: SUPERCONDUCTIVITY

Sources of superconductivity – The Meissner effect – Thermodynamics of superconducting transitions – Origin of energy gap – London equations –London Penteration depth – Type I and Type II Sueprconductors - Coherence length – BCS theory – Flux quantization – Theory of DC and AC Josephesen effect – Potential applications of superconductivity.

UNIT-V: OPTICAL AND THERMAL PROPERTIES OF MATERIALS

Absorption processes- Photoconductivity – Photoelectric effect – Photovoltaic effect – Photoluminescene – Colour centres – Types of colour centres – Generation of colour centres. Classical lattice heat capacity – Quantum theory of lattice heat capacity: average thermal energy of a harmonic oscillator, Einstein Model and Debye Continuum model – Anharmonic effects: thermal expansion and Phonon collision process.

Books for Study and Reference:

1. Solid State Physics: Structure and Properties of Materials, A.M.Wahab, 2nd Edition, Narosa Publishing house, New Delhi, India, 2007.
2. Elementary Solid State Physics: Principles and Applications, M.A.Omar, 4th Edition, Pearson Education Pvt. Ltd., Delhi, India, 2004.
3. Introduction to Solid State Physics, C. Kittel, 7th Edition, John –Wiley & Sons Pvt Ltd., New Delhi, 1996.
4. Elements of Solid State Physics, J.P.Srivastava, 2nd Edition, Printice Hall of India, New Delhi, 2001.
5. Solid State Physics, S.O.Pillai, 4th Edition, New Age International Publishers, New Delhi, 2001.
6. Solid State Physics, Ashcroft and Mermin, 1st Edition, Eastern Press Pvt Ltd, Bangalore, 2003.
7. Introductory to Solid State Physics, H.P.Myers, 2nd Edition, Taylors and Francis Ltd, London, 1998.

Tutorials:

1. In an intrinsic semiconductor, the effective mass of an electron is 0.07 m_o and that of hole is 0.4 m_o, where m_o is the rest mass of the electron. Calculate the intrinsic concentration of charge carriers at 300 K. (Given the energy gap = 0.7 eV)
2. If a sample of silicon is doped with 3×10^{23} arsenic atoms and 5×10^{23} atoms of boron. Determine the electron and hole concentrations if the intrinsic charge carriers of silicon are $2 \times 10^{16}/ m^3$
3. The polarizability of NH_3 molecule in the gaseous state, from the measurement of dielectric constant is found to be 2.42×10^{-39} Fm^2 at 309 K and 2×10^{-39} Fm^2 at 448 K, respectively. Calculate for each temperature the polarizability due to permanent dipole moment and due to deformation of molecules.
4. The magnetic field intensity in a piece of ferric oxide is 10^6 ampere/metre. If the susceptibility of the material at room temperature is 1.5×10^{-3}, calculate the flux density and magnetization of the materials.

5. The critical temperature for mercury with isotopic mass 199.5 is 4.185K. Calculate its critical temperature when its isotopic mass changes top 203.4
6. The penetration depths for lead are 396 Å and 1730 Å at 3 K and 7.1K, respectively. Calculate the critical temperature for lead.
7. Diamond (atomic weight of carbon = 12) has Youngs modulus of 10^{12} Nm^{-2} and a density of 3500 kg/m^3. Compute the Debye temperature for diamond.
8. A photon of wavelength 1400 Å is absorbed by cold mercury vapour and two other phonons are emitted. If the wavelength of one of them is 1850 Å, what is the wavelength of the other photon?

2EB ENVIRONMENTAL BIOTECHNOLOGY

UNIT–I: ENERGY AND ENVIRONMENT

Non-Conventional energy sources: hydroelectric, wind, tidal ocean, thermal energy, geothermal, solar energy collectors, hydrogen, magneto hydrodynamic, nuclear energy, chemical energy, bio-energy (energy from biomass).

UNIT-II: ENVIRONMENTAL POLLUTION

Types of pollution, methods for the measurement of pollution, air pollution and its control, global environmental problems: ozone depletion, green house effect and acid rain, principles of conservation and application of biotechnology, remote sensing and GIS (Principal and applications in ecological mapping and environmental hazard predictions), ecological modeling, bioindicators and biosensors for detection of pollution. Solid waste: Sources and management (composting, vermiculture and methane production).

UNIT–III: WATER POLLUTION AND CONTROL

Need for water management, measurement and sources water pollution. waste water treatment: waste water collection, physico-chemical properties of waste water, physical, chemical and biological treatment processes. activated sludge, oxidation ditches, trickling filter, rotating discs, rotating drums, oxidation ponds. anaerobic digestion, anaerobic filters, up flow anaerobic sludge blanket reactors. treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries.

UNIT–IV: XENOBIOTICS

Ecological considerations, degradative plasmids; hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. biopesticides; bioremediation of contaminated soils and wastelands.

UNIT–V: ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL ACTS

Ecoplanning and sustainable development: Indian standards IS:2490, IS:3360, IS:3307, IS:2296, ISO: 14000 series, MINAS for industries and ecomarks, public liability

insurance act, ElA guidelines and assessment methods, environmental priorities in India and agenda 21 and carbon credit.

References

1. Environmental Biotechnology, Alan Scragg, Pearson Education Limited, England, 2005.
2. Environmental Biotechnology, S.N. Jogdand, Himalaya Publishing House, Bombay, 1996.
3. Wastewater Engineering – Treatment, Disposal and Reuse, Metcalf and Eddy, Inc., Tata Mc Graw Hill, New Delhi, 2004.
4. Environmental chemistry, A.K. De, Wiley Eastern Ltd, New Delhi, 2003.
5. Introduction to Biodeterioration, D. Allsopp, C. Gaylarde and k.J. Seal, ELBS/Edward Arnold, 2004.
6. Environmental Science, WP Cunninghum & BW Saigo., 5th edition, Mc Graw Hill, 1999.
7. Biotechnology for Wastewater Treatment, P Nicholas Cheremisinoff, Prentice Hall Of India, 2001.
8. Biotechnological Methods of Pollution Control, SA Abbasi and E Ramaswami, Universities Press, 1999.
9 Environmental Biotechnology, Concepts and Applications, Hans-Joachin Jordening and JosefWinter, Winter-VCH, 2005
10. Biology of wastewater Treatment, N F Gray, Mc Graw Hill, 2004.
11. Environmental Biotechnology: Principles and Applications, Bruce Rittmann and Perry McCarty, Mc Graw Hill, 2001.

23P PRACTICAL-II

1. Michelson Interferometer Experiment
2. Hall effect in semiconductor
3. Determination of the refractive index of the given samples.
4. Determination of the diameter of the given circular aperture (Three holes)
5. Determination of the particle size of the given materials using He-Ne LASER.
6. XRD analysis of the given XRD spectra
7. Determination of thickness by the envelope method and calculate the band gap of the given transmittance specta.
8. Determination of the wavelength of the given LASER using Vernier Caliper/steel scale and grating elements.
9. Polymer synthesis in bulk
10. Polymer synthesis by suspension method
11. Polymer synthesis by emulsion method
12. Preparation of polyurethane foams
13. Suspension copolymerization
14. IR and NMR spectra of polymers
15. Photopolymerization
16. Introduction to plant tissue culture-induction of callus and suspension cultures
17. Extract the genomic DNA from plants by CTAB method and resolve in the agarose gel
18. Plant genomic DNA isolation from a medicinal plant
19. Isolation of microorganisms from various environments.

20. Cultivation of bacteria, antinomycetes, fungi and archaea
21. Staining techniques and microscopy
22. Biochemical observations of bacteria
23. Blood typing
24. Double immunodiffusion

33A SPECTROSCOPY

UNIT-I

Rotation of molecules and their spectra – diatomic molecules – intensity of line spectra – the effect of isotropic substitution – non-rigid rotator and their spectra – polyatomic molecules (linear and symmetric top molecules) – Classical theory of Raman effect - pure rotational Raman spectra (linear and symmetric top molecules).

UNIT-II

The energy of diatomic molecules – Simple Harmonic Oscillator –the Anharmonic oscillator – the diatomic vibrating rotator – vibration-rotation spectrum of carbon monoxide – breakdown of Born-Oppenheimer approximation – the vibrations of polyatomic molecules – influence of rotation on the spectra of polyatomic molecules (linear and symmetric top molecules) – Raman activity of vibrations – vibrational Raman spectra – vibrations of Spherical top molecules.

UNIT-III

Electronic wave function and atomic quantum numbers – hydrogen spectrum – orbital, spin and total angular momentum - fine structure of hydrogen atom – many electron spectrum: Lithium atom spectrum, angular momentum of many electrons – term symbols – the spectrum of helium and alkaline earths – equivalent and non equivalent electrons – basics of X-ray photoelectron spectroscopy.

UNIT-IV

Diatomic molecular spectra: Born-Oppenheimer approximation – vibrational spectra and their progressions – Franck-Condon principle – dissociation energy and their products – rotational fine structure of electronic-vibration transition - molecular orbital theory – the spectrum of molecular hydrogen – change of shape on excitation – chemical analysis by electronic spectroscopy – reemission of energy – fundamentals of UV photoelectron spectroscopy.

UNIT-V

Spin and magnetic field interaction – Larmor precession – relaxation time – spin-spin relaxation - spin–lattice relaxation - NMR chemical shift - coupling constants – coupling

between nuclei – chemical analysis by NMR – NMR for nuclei other than hydrogen - ESR spectroscopy - fine structure in ESR.

Text Book

1. Fundamentals of Molecular Spectroscopy by Colin N. Banwell and Elaine M. McCash (Tata McGraw-Hill Publishing Company limited)

Reference:

1. Physical method for Chemists, Russell S. Drago, 2nd Edition, Saunders College Publishing, 1992.

33B NANOBIOTECHNOLOGY

UNIT-I: BIOLOGICAL NANO-OBJECTS

Structural and Functional Regulation of DNA: Geometry, Topology and Methylation : Geometry of the DNA Double Helix - The Z Conformation of DNA.- Supercoiled DNA - Methylation of DNA - Protein–Lipid Assembly and Biomimetic Nanostructures : Introduction: Biological Membranes - Lipid Membranes: Structure and Properties - Models and Methods for Characterising Membranes - Protein–Lipid Assembly - Applications of Biomimetic Membranes

UNIT-II: FUNCTIONALISED INORGANIC NANOPARTICLES FOR BIOMEDICAL APPLICATIONS AND LIVING MACHINES

Synthesis and Chemical Surface Modification of Inorganic Nanoparticles – Biological Tagging in Vitro and in Animals - *In-Vivo* Applications - Living Nanomachines: Introduction - Force and Motion by Directed Assembly of Actin Filaments - Molecular Motors: Myosins and Kinesins - ATP Synthase.

UNIT-III: METHODS OF NANOBIOTECHNOLOGY

Optical tools – Nanoforce and imaging – Surface methods – Mass spectrometry – Electrical Characterization and Dynamics of Transport – Microfludics : Concepts and Applications to the Life Sciences.

UNIT-IV: APPLICATIONS OF NANOBIOTECHNOLOGY

Real Time PCR – Biosensors : From the Glucose electrode to the Biochip – DNA Microarrays – Protein Microarrays – Cell Biochips – Lab on a chip – Polyelectrolyte multilayers – Biointegrating materials – Pharmaceutical applications of nanoparticles carriers.

UNIT-V: MAJOR PHYSIOLOGIC SYSTEMS OF CURRENT INTEREST TO BIOMEDICAL ENGINEERS

Cardiovascular, endocrine, nervous, visual, auditory, gastrointestinal, and respiratory. Useful definitions. The status of tissue engineering of specific organs, including bone marrow, skeletal muscle, and cartilage. Cell biological fundamentals of tissue engineering. Nanoparticle-biomaterial hybrid systems Biomaterial based metallic nanowires, networks.

Text Book

1. Nanoscience : Nanobiotechnology and Nanobiology, P. Boisseau, P. Houdy and M. Lahmani, Springer, 2007.
2. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology, Hari Singh Nalwa, American Scintific Publishers, 2005.
3. Nanobiotechnology, C.M.Niemeyer, C.A. Mirkin, Wiley VCH, 2004.
4. Nanocomposite Science & Technology, Ajayan, Schadler & Braun, Wiley VCH, 2005.

References

1. Nanoelectronics and Nanosystems: From Transistors to Molecular Devices, K.Goser, P. Glosekotter, J. Dienstuhl, Springe, 2004.
2. Nanotechnology: Basic Science and Emerging Technologies, Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press, 2005.
3. Nanobiotechnology**:** Concepts, Applications and Perspectives, Christof M.Niemeyer, Chad A.Mirkin, Wiley-VCH, Weinheim, 2004.
4. Bionanotechnology : Lessons from Nature**,** David S. Goodsell, Wiley-Liss, 2004.
5. NanoBiotechnology Protocols**,** Sandra J. Rosenthal, David W.Wright, Humana Press, New Jersey, 2005.
6. Protein Nanotechnology, Protocols, Instrumentation and Applications, Tuan Vo-Dinh, Humana Press, New Jersey, 2005.

33C MICRO AND NANOFABRICATION

UNIT-I: BASIC MICROFABRICATION TECHNIQUES

Basic Microfabrication Techniques: Lithography - Thin Film Deposition and Doping : Oxidation – Doping – Chemical Vapor Deposition and Epitaxy – Physical Vapor Deposition – Electroplating - Etching and Substrate Removal : Wet Etching – Dry Etching – Substrate Bonding : Si Direct Bonding – Anodic Bonding – Bonding with Intermediate Layers.

UNIT-II: MEMS AND NEMS

MEMS Fabrication Techniques: Bulk Micromachining - Surface Micromachining - High-Aspect-Ratio Micromachining - Nanofabrication Techniques: e-Beam and Nano-Imprint Fabrication - Epitaxy and Strain Engineering - Scanned Probe Techniques - Self-Assembly and Template Manufacturing.

UNIT-III: MATERIALS ASPECTS AND APPLICATIONS OF MEMS/NEMS

Silicon - Germanium-Based Materials – Metals - Harsh Environment Semiconductors - GaAs, InP, and Related III-V Materials - Ferroelectric Materials - Polymer Materials - Future Trends - MEMS Devices and Applications - NEMS Devices and Applications - Current Challenges and Future Trends.

UNIT-IV: NANOFABRICATION USING CARBON NANOMATERIALS

Microfabrication – nanofabrication – nanofabrication using soft lithography – nanofabrication using manipulative techniques – nanofabrication using carbon nanomaterials.

UNIT-V: CLEAN ROOM AND PROCESS INTEGRATION

Clean Rooms: Clean room standards – Clean room sub systems – Environment, Safety and Health Aspects – Process Integration : Junction and Oxide Isolation – LOCOS Methods – Trench Isolation – Silicon on Insulator Isolation Techniques – Semi insulating Substrates – Schottky Contacts – Implanted Ohmic Contacts – Alloyed Contacts – Multilevel Metallization – Planarization and Advanced Interconnect. **Text**

Text Books

1. Springer Handbook of Nanotechnology, Bharat Bhushan, Springer, 2004.
2. Introduction to Microfabrication, Sami Franssila, John Wiley & Sons Ltd, 2004.
3. The Science and Engineering of Microelectronic Fabrication, Stephen A. Campbell, Oxford University Press 2001.

References

1. Microfabrication and Nanofabrication, Mark J. Jackson, CRC Taylor & Fancis, 2006.
2. Nano and Microelectromechanical Systems : Fundamentals of Nano and Microengineering, Sergey Edward Lyshevski, CRC Press, 2001.

33D (P) ELECTROMAGNETIC THEORY

UNIT-I: ELECTROSTATICS

Columb's law – surface, line and volume charge distributions - Gauss' Law and its applications; Electrostatic potential - Laplace and Poisson equations – Potential of a localised charged distributions – Laplace equation in one, two and three dimensions – Boundary conditions and Uniqueness theorems.

UNIT-II: MAGNETOSTATICS

Lorentz force law- Biot-Savart law – condition for steady electric current - Ampere's law – Application of Ampere's law – comparison of Magnetostatics and Electrostatics – Magnetic vector and Scalar potential Magneto static boundary conditions

UNIT-III: ELECTRODYNAMICS

Electromotive force – ohms law – Faradays law – Induced electric field – Energy in magnetic fields – Maxwell's equation in free space – Magnetic charge - Maxwells equation in matter – Boundary conditions - Conservation laws – Conservation of energy – Poynting's theorem - conservation of momentum .

UNIT-IV: ELECTROMAGNETIC WAVES AND INTERACTION WITH MATTER

Electromagnetic waves in vacuum – Energy and momentum of EMW – EMW in matter – Propagation in linear media – Reflection and transmission at Normal incidence – Reflection and Transmission at Oblique incidence – Implications: Laws of incidence and reflectance, snell's law, Brewster law – Freshnel's equations.

UNIT-V: APPLICATIONS – PLASMA PHYSICS

Plasma – Plasma criteria – Debye shielding (DC current) – Plasma frequency (AC shielding) – Motion charge particles in uniform E and B field - non uniform B field – non uniform E field – time varying E field – time varying B field – guiding centre drifts – plasma confinement

Books for Study and Reference:

1. Introduction to Electrodynamics, David J. Griffiths, Prentice Hall, 1999.
2. Feyman Lectures, Vol. 2, Richard Feyman, 2008.
3. Classical Electrodynamics, J.D. Jackson, John Wiley and Sons, New York, 1975.
4. Classical Electrodynamics, Hans C. Ohanian, 2nd Edition, Infinity Science press, New Delhi, 2009.

Tutorials:

1. Calculation of electric field around a charged sphere and wire
2. Representation of Divergence, Curl and gradient into Spherical and cylindrical co-ordinates

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33D (C) INORGANIC CHEMISTRY - II

UNIT-I

Definition of organometallic compound - 18 electron rule - effective atomic number rule - classification of organometallic compounds - the metal carbon bond types - ionic bond - sigma covalent bond - electron deficient bond - delocalised bond - dative bond - metal carbonyl complexes - synthesis - structure and reactions of metal carbonyls - the nature of M- CO bonding - binding mode of CO and IR spectra of metal carbonyls - metal carbonyls- metal carbonyl anions - metal carbonyl hydrides - metal carbonyl halides - metal carbonyl clusters - Wades rule and isolobal relationship - metal nitrosyls - dinitrogen complexes - dioxygen complexes.

Unit-II

Metal alkyl complexes - stability and structure - synthesis by alkylation of metal halides - by oxidative addition - by nucleophilic attack on coordinated ligands - metal alkyl and 18 electron rule - reactivity of metal alkyls - M-C bond cleavage reactions - insertion of CO to M-C bonds - double carbonylation - insertions of alkenes and alkynes - insertions of metals with C-H bonds - alkylidene and alkylidyne complexes - synthesis of alkylidene complexes in low oxidation states and in high oxidation states - bonding in alkylidene complexes - synthesis and bonding in alkylidyne complexes - reactivity of alkylidene and alkylidyne complexes.

Unit-III

Alkene complexes - synthesis of alkene complexes by ligand substitutuion - by reduction and by metal atom synthesis - bonding of alkenes to transition metals - bonding in diene complexes - reactivity of alkene complexes - ligand substitution - reactions with nucleophiles - olefin hydrogenation - hydrosilation - Wacker process - C-H activation of alkenes - alkyne complexes - bonding in alkyne complexes - reactivity of alkynes - alkyne complexes in synthesis - cobalt catalysed alkyne cycloaddition.

UNIT-IV

Cyclopentadienyl complexes - metallocenes - synthesis of metallocenes - bonding in metallocenes - reactions of metallocenes - Cp_2Fe/Cp_2Fe^+ couples in biosensors - bent sandwich complexes - bonding in bent sandwich complexes - metallocene halides and hydrides - metallocene and stereospecific polymerisation of 1-alkenes - cyclopentadiene as a non-spectator ligand - monocyclopentadienyl (half-sandwich) complexes - synthesis and structures of allyl complexes - arene complexes - synthesis - structure and reactivity of arene complexes - multidecker complexes.

UNIT-V

Organometallic compounds in homogeneous catalytic reactions - coordinative unsaturation - acid-base behaviour reaction - migration of atoms or groups from metal to ligand - insertion reaction - reactions of coordinated ligands - catalytic reactions of alkenes - isomerisation of alkenes - hydrogenation - hydroformylation and hydrosilation of alkenes - alkene polymerisation and oligomerisation - fluxional molecules.

References

1. Organometallics 1, complexes with transition metal-carbon -bonds, Bockmann, Oxford science publications, Oxford, 1996.
2. Organometallics 2, complexes with transition metal-carbon -bonds, Bockmann, Oxford science publications, Oxford, 1996.
3. Basic organometallic chemistry, J. Haiduc and J. J. Zuckerman, W. de Gruyter, Brelin, 1985.
4. Inorganic Chemistry - Priciples of structure and reactivity, J. E. Huheey Harper International Edition, Harper and Rone New York, 1978.
5. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, Fourth Edition.

33D (B) SYSTEM PHYSIOLOGY

UNIT-I: BASIC CONCEPTS OF DEVELOPMENT

Production of gametes, cell surface molecules in sperm egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; Morphogenesis and organogenesis in animals (Drosophila, Amphibia and Chick). Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants; imprinting. Embryogenesis in plants (Arabidopsis).

UNIT-II: PLANT SYSTEM PHYSIOLOGY

Photosynthesis: Mechanism of photosynthesis; Plant hormones: biosynthesis, storage, breakdown and transport; physiological effects and mechanism of action. Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism. Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates, biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress.

UNIT-III: DIGESTION AND HAEMATOLOGY:

Homeostasis, nutrition, structure and functions of digestive system. Physiology of digestion. Blood corpuscules, haemopoiesis, plasma function, blood volume, haemostasis. Comparative anatomy of heart structure, myogenic heart, ECG- its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.

Unit-IV: Respiration and Excretion:

Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, electrolyte balance and acid-base balance.

UNIT-V: NERVOUS SYSTEM:

Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system. Types, structure and functions of muscles, Physiology of musle contraction. Sense organs: vision, hearing and tactile response. Endocrine glands, basic mechanism of hormone action, hormone and diseases; reproductive processes, neuroendocrine regulation. Thermoregulation.

References

1. An introduction to embryology, Balinsky, Saunders College Pub, 1981.
2. Developmental biology, Gilbert, INC Publishers, 2000.
3. Chordate embryology, Verma, Agarwal and Tyagi, S. Chard & Co, 1995.
4. Plant physiology, Delwin and Withem, PWS Publishers, 1983.
5. Plant physiology, Lincoin Taiz, Eduardo Zeiger Publishers, Sinauer 2006.

3EC APPLICATIONS OF NANOTECHNOLOGY

UNIT-I: SENSORS

Sensors - Nanotechnology Enabled Sensors - Sensor Characteristics and Terminology - Static and Dynamic Characteristics; Inorganic Nanotechnology Enabled Sensors - Gas Sensing with Nanostructured Thin Films - Phonons in Low Dimensional Structures - Nanotechnology Enabled Mechanical Sensors - Nanotechnology Enabled Optical Sensors - Magnetically Engineered Spintronic Sensors; Organic Nanotechnology Enabled Sensors - Surface Interactions - Surface Materials and Surface Modification - Proteins in Nanotechnology Enabled Sensors - Nano-sensors based on Nucleotides and DNA.

UNIT-II: ENERGY DEVICES

Solar Cells - Band Diagram and Operational Principle of Nanocrystalline Solar Cells - The Importance of the Nanostructure - Quantum Dot Sensitizer; Electrochemistry and Nanoscale Materials - Electrochemistry and Size Effects - Challenges of Charge Transfer - Nanomaterials and Nanostructured Films as Electro active Electrodes - Nanomaterials as Electrolytes - Nanoscale Electronic and Ionic Transport – Energy Conversion and Storage in Electrochemistry - Overview of the Principles of Operation of Energy Conversion and Storage Devices - Lithium Ion Batteries - Fuel Cells - Photoelectrochemical Solar Cells - Electrochemical Double-Layer Capacitors - What Relevance Has Nanotechnology for Fuel Cell Systems - Fuel Cell Technology and Nanotechnology.

UNIT-III: BIOMEDICAL APPLICATIONS

Quantum Dots as Tracers for DNA Electrochemical Sensing Systems - Introduction - QD Bionanostructures - Characterization of QD Biostructures - Electrochemical Sensing Formats - Future Prospects; Magnetic Nanoparticles as Contrast Agents for Medical Diagnosis - Nanoparticles in Medicine - Size-Dependent Effects of Magnetic Particles – Preparation - Methods for Iron Oxide Nanoparticles and *in-vitro* Characterization – *in-vivo* Investigations - Using Nanoparticles in Animals - Magnetic Nanoparticles for Imaging and Therapy in Humans - Toxicity of Nanoparticles - Future Perspectives.

UNIT-IV: POTENTIAL DEFENCE APPLICATIONS

Military applications of Nanotechnology - Electronics, photonics, magnetic - Computers, Communication - Software/Artificial Intelligence – Materials -Energy Sources, Energy Storage - Propulsion – Vehicles - Propellants and Explosives – Camouflage -Distributed

Sensors - Amour, Protection - Conventional Weapons - Soldier Systems - Implanted Systems, Body Manipulation - Autonomous Systems - Mini-/Micro Robots - Bio-technical Hybrids - Small Satellites and Space Launchers - Nuclear Weapons - Chemical Weapons - Biological Weapons - Chemical/Biological Protection.

UNIT-V: NANOSTRUCTURED FOOD AND PACKAGING MATERIALS

Natural Food Nanostructures - Naturally Occurring Food Nanosubstances and Nanostructures - Designing Food Nanostructures - The Status of Natural Nanostructures in Food - Nanomaterials for (Health)food Applications - Nano-sized Food Ingredients and Additives in Relation to Digestion of Food - Nanotechnologies in Food Packaging - Improvement of Mechanical Properties through Nanocomposites - Improvement of Barrier Properties - Improvement of the Performance of Bio-based Polymers - Surface Biocides - Active Packaging Materials - Intelligent Packaging Concepts.

Text Books

1. Nanotechnology - Enabled Sensors, Kourosh Kalantar-zadeha and Benjamin Fry, Springer, 2008.
2. Nanostructured Materials for Electrochemical Energy Production and Storage, David J. Lockwood, Springer, 2009.
3. Nanotechnology in Biology and Medicine: Methods, Devices and Applications, Tuan Vo-Dinh, CRC Press, 2007.
4. Military Nanotechnology: Potential Applications and Preventive Arms Control, Jürgen Altmann, Routledge, Taylor and Francis Group, 2006.
5. Nanotechnologies in Food, Qasim Chaudry, Laurence Castle and Richard Watkins, RSC Publications, 2010.

References

1. Recent Trends in Fuel Cell Science and Technology, Edited by Suddhasatwa Basu, Springer (2007).
2. Nanomedicine, Vijay K. Varadan, Linfeng Chen, Jining Xie, A John Wiley and Sons, Ltd., Publication (2008).
3. Biological Nanostructures and Applications of Nanostructures in Biology : Electrical, Mechanical, and Optical Properties, Edited by Michael A. Stroscio and Mitra Dutta, Kluwer Academic Publishers (2004).

33P – PRACTICAL III

1. Verification of Lambert Beer's law and determination of concentration of unknown solution by UV-Vis spectrophotometer.
2. Preparation of colloidal Silver (Ag) nanoparticles with trisodium citrate and their characterization
   by UV-Vis spectroscopy.
3. To study Hydrogen bonding by FT-IR spectroscopy
4. Preparation of metal oxide nanoparticles by microemulsion technique

5. Characterization of prepared metal oxide nanoparticles by XRD and determination of their size by Scherrer's Equation.
6. To determine the Band-Gap of given Semiconductor using Four Probe Method from Liquid Nitrogen Temp to Room Temperature
7. Synthesis of at least two different sizes of Nickel Oxide Nano Particles Using Sol-Gel Method
8. Synthesis of at least two different sizes of Copper Oxide Nano Particles Using Sol-Gel Method
9. Synthesis of at least two different sizes of Zinc Oxide Nano Particles Using Sol-Gel Method
10. Preparation of quantum dot (ZnS) nanoparticles and estimation of band gap from band edge
11. Synthesize copper oxide nanoparticles by sol-gel method and determine the average size of nanoparticles using Zeta sizer.
12. Fabricate silver nanoparticles embedded in silica glass by ion exchange method and study surface plasmon resonance using UV-visible spectroscopy.
13. Fabricate copper nanoparticles embedded in silica glass by ion exchange method and determine the size of nanoparticles using optical absorption spectroscopy.
14. Synthesize silver nanocrystals in solution by citrate reduction method and study the effect of capping using optical absorption spectroscopy.
15. Study the growth kinetics of silver nanoparticles embedded in ion exchanged glass at different temperatures using optical absorption spectroscopy.
16. Viscosity of mixtures
17. Cryoscopy, rast amd Ebulioscopy
18. Phase rule - transition temperature, c.s.t., eutectic, compound formation partition
19. Heat of neutralisation, combustion
20. Drug administration methods