BHARATHIAR UNIVERSITY, COIMBATORE 641 046
UNIVERSITY DEPARTMENT
M.Sc., NANOSCIENCE AND TECHNOLOGY
(For the candidates admitted from the academic year 2015-16 onwards)
SCHEME OF EXAMINATION (CBCS PATTERN)

Sem	Paper		Subject	Credit
I	Core –1		Fundamentals of Nanoscale Science and Technology	4
	Core – 2	P	Classical Mechanics	4
		C	Organic Chemistry – I	
		B	Biochemistry	
	Core – 3	P	Quantum Mechanics	4
		C	Inorganic Chemistry - I	
		B	Microbiology	
	Core – 4	P	Mathematical Physics	4
		C	Physical Chemistry - I	
		B	Cell and Molecular Biology	
	Elective – 1		Analog and Digital Electronics/Analytical Chemistry/ Biostatistics	4
	Supportive -1		Offered from other Departments	2
II	Core – 5		Synthesis and Fabrication of Nanomaterials	4
	Core – 6		Properties of Nanomaterials	4
	Core – 7	P	Statistical Mechanics and Thermodynamics	4
		C	Organic Chemistry - II	
		B	Immunology	
	Core – 8	P	Nuclear and Particle Physics	4
		C	Physical Chemistry – II	
		B	Pharmaceutical Biotechnology	
	Elective - 2		Advanced Materials Science/ Environmental Biotechnology	4
	Core –9		Practical – I	4
	Supportive-2		Offered from other Departments	2
III	Core –10		Modern Instrumental Methods for Materials Analysis	4
	Core – 11		Nanobiotechnology	4
	Core – 12		Micro and Nanofabrication	4
	Core – 13	P	Electromagnetic Theory	4
		C	Inorganic Chemistry – II	
		B	Toxicology	
	Elective – 3		Nanodevices and Applications	4
	Core – 14		Practical - II	4
	Core – 15		Mini Project and Study Tour	2
	Supportive -3		Offered from other Departments	2
IV	Core – 16		IPR and Biosafety (Self Study)	2
	Core –17		Project and Viva – Voce	12
			Total	**90**

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

M.Sc., NANOSCIENCE AND TECHNOLOGY (Physics Based) SCHEME (CBCS PATTERN)

Sem	Code No.	Subject	Class hours	University Examination			
				Internal	External	Total	Credit
I	13A	Fundamentals of Nanoscale Science and Technology	4	25	75	100	4
	13B	Classical Mechanics	4	25	75	100	4
	13C	Quantum Mechanics	4	25	75	100	4
	13D	Mathematical Physics	4	25	75	100	4
	1EA	Analog and Digital Electronics	4	25	75	100	4
	1GS..	Supportive - I	2	12	38	50	2
							22
II	23A	Synthesis and Fabrication of Nanomaterials	4	25	75	100	4
	23B	Properties of Nanomaterials	4	25	75	100	4
	23C	Statistical Mechanics and Thermodynamics	4	25	75	100	4
	23D	Nuclear and Particle Physics	4	25	75	100	4
	2EB	Advanced Materials Science	4	25	75	100	4
	23P	Practical – I	6	25	75	100	4
	2GS..	Supportive – II	2	12	38	50	2
							26
III	33A	Modern Instrumental Methods for Materials Analysis	4	25	75	100	4
	33B	Nanobiotechnology	4	25	75	100	4
	33C	Micro and Nanofabrication	4	25	75	100	4
	33D	Electromagnetic Theory	4	25	75	100	4
	3EC	Nanodevices and Applications	4	25	75	100	4
	33P	Practical - II	6	25	75	100	4
	3GS..	Supportive - III	2	12	38	50	2
	37V	Mini Project and Study Tour	-	50	-	50	2
							28
IV	43A	IPR and Biosafety (Self Study)	4	--	50	50	2
	47V	Project and Viva – Voce	26	75	225	300	12
							14
						2250	**90**

M. Sc., NANOSCIENCE AND TECHNOLOGY (Chemistry Based) SCHEME (CBCS PATTERN)

Sem	Code No.	Subject	Class hours	University Examination			
				Internal	External	Total	Credit
I	13A	Fundamentals of Nanoscale Science and Technology	4	25	75	100	4
	13E	Organic Chemistry – I	4	25	75	100	4
	13F	Inorganic Chemistry – I	4	25	75	100	4
	13G	Physical Chemistry – I	4	25	75	100	4
	1EB	Analytical Chemistry	4	25	75	100	4
	1GS..	Supportive – I	2	12	38	50	2
							22
II	23A	Synthesis and Fabrication of Nanomaterials	4	25	75	100	4
	23B	Properties of Nanomaterials	4	25	75	100	4
	23E	Organic Chemistry – II	4	25	75	100	4
	23F	Physical Chemistry – II	4	25	75	100	4
	2EA	Advanced Materials Science	4	25	75	100	4
	23P	Practical – II	6	25	75	100	4
	2GS..	Supportive – II	2	12	38	50	2
							26
III	33A	Modern Instrumental Methods for Materials Analysis	4	25	75	100	4
	33B	Nanobiotechnology	4	25	75	100	4
	33C	Micro and Nanofabrication	4	25	75	100	4
	33E	Inorganic Chemistry – II	4	25	75	100	4
	3EC	Nanodevices and Applications	4	25	75	100	4
	33P	Practical – II	6	25	75	100	4
	3GS..	Supportive – III	2	12	38	50	2
	37V	Mini Project and Study Tour	2	50	-	50	2
							28
IV	43A	IPR and Biosafety (Self Study)	4	--	50	50	2
	47V	Project and Viva – Voce	26	75	225	300	12
							14
						2250	**90**

M. Sc., NANOSCIENCE AND TECHNOLOGY (Biotechnology Based) SCHEME (CBCS PATTERN)

Sem	Code No.	Subject	Class hours	University Examination			
				Internal	External	Total	Credit
I	13A	Fundamentals of Nanoscale Science and Technology	4	25	75	100	4
	13H	Biochemistry	4	25	75	100	4
	13I	Microbiology	4	25	75	100	4
	13J	Cell and Molecular Biology	4	25	75	100	4
	1EC	Biostatistics	4	25	75	100	4
	1GS..	Supportive – I	2	12	38	50	2
							22
II	23A	Synthesis and Fabrication of Nanomaterials	4	25	75	100	4
	23B	Properties of Nanomaterials	4	25	75	100	4
	23G	Immunology	4	25	75	100	4
	23H	Pharmaceutical Biotechnology	4	25	75	100	4
	2EB	Environmental Biotechnology	4	25	75	100	4
	23P	Practical – II	6	25	75	100	4
	2GS..	Supportive – II	2	12	38	50	2
							26
III	33A	Modern Instrumental Methods for Materials Analysis	4	25	75	100	4
	33B	Nanobiotechnology	4	25	75	100	4
	33C	Micro and Nanofabrication	4	25	75	100	4
	33F	Toxicology	4	25	75	100	4
	3EC	Nanodevices and Applications	4	25	75	100	4
	33P	Practical – II	6	25	75	100	4
	3GS..	Supportive – III	2	12	38	50	2
	37V	Mini Project and Study Tour	-	50	--	50	2
							28
IV	43A	IPR and Biosafety (Self Study)	4	--	50	50	2
	47V	Project and Viva – Voce	26	75	225	300	12
							14
						2250	**90**

Course Code and Title : 13A - Fundamentals of Nanoscale Science and Technology

Course Type : Core **Semester** : I **Credits**: 4

Unit-I - Generic Methodologies for Nanotechnology

Introduction and classification - 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} - 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 semiconductor physics - Quantum confinement - The electronic density of states - Fabrication techniques - Physical Processes of semiconductor nanostructures - The characterisation of semiconductor nanostructures - Applications.

Unit-IV - Nanostructured Molecular Materials

Introduction; Building blocks - Self-assembly - Principles - Methods to Prepare and Pattern Nanoparticles - Templated Nanostructures - Liquid Crystal Mesophases - Macromolecular interfaces - The principles of interface science - Analysis of wet interfaces - Interface Modification - organic thin films - Surface effects on phase separation - Nanopatterning surfaces by self-assembly - nanoscale devices exploiting macromolecular 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.

References

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.

Course Code and Title : 13B – Classical Mechanics

Course Type : Core (for Physics) **Semester : I** **Credits: 4**

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.

References

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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Course Code and Title : 13E – Organic Chemistry - I

Course Type : Core **Semester : I** **Credits: 4**

Unit–I

*Aromaticity***:** Criteria - Huckel's rule – diatropic molecules-Aromaticity of Benzenoids and heterocyclic compounds. Non-benzenoid aromatics – azulene, ferrocene, tropolone, sydnones and annulenes (synthesis not required) - Non-aromatic and anti-aromatic systems.
Study of Organic Reaction Mechanism - non-kinetic methods – product analysis intermediate criteria (isolation, trapping and detection) - isotopic labelling and cross over experiments-stereochemical evidence - energy profile diagrams – intermediate vs. transition state. Kinetic methods - mechanistic implications of rate law - isotope effects – kinetic and thermodynamic control of reactions – Hammond's postulate – linear free energy relationship - Hammett and Taft equations

Unit-II

Aromatic Electrophilic Substitution – mechanism, orientation and reactivity of mono and disubstituted benzenes. Specific reactions - Friedel - Craft's alkylation and acylation - Formylations(Gattermann, Gattermann-Koch, Reimer-Tiemann, Kolbe's, Vilsmeier-Haack), Bischler-Napieralski, Hofmann-Martius and Jacobson reactions.

Aliphatic Electrophilic Substitution - SE^1, SE^2 and SE^i mechanisms - Friedel-Craft's acylation at olefinic carbon - Stork-enamine reaction - decarboxylation of aliphatic acids.

Unit-III

Aliphatic Nucleophilic Substitution – SN^1, SN^2, ion-pair, SN^i mechanisms-neighbouring group participation – stereochemistry – Reactivity - effect of substrate structure, nucleophile,

leaving group, and the reaction medium - ambient nucleophiles (regioselectivity) and ambient substrate- hydrolysis of esters.

Aromatic Nucleophilic Substitution - SN^1, SNAr and benzyne mechanisms - structure and reactivity - effect of substrate structure, leaving groups and nucleophile -typical reactions - Bucherer, Rosenmund, Von-Braun, Ziegler, Chichibabin reactions - Von-Richter, Sommlett – Hauser and Smiles rearrangements.

Unit-IV

Elimination Reactions – E_1, E_2 and E_1cB mechanisms-structural and stereochemical factors governing eliminations, Hofmann and Saytzeff rule – Bredt's rule –elimination vs. substitution-pyrolytic eliminations-Chugaev reaction-Hofmann degradation - Cope elimination.

Addition Reactions: Electrophilic, nucleophilic and free radical addition to double and triple bonds-hydration, hydroxylation (OsO_4, $KMnO_4$, H_2O_2, Woodward & Prevost methods), Michael addition, hydroboration and epoxidation-sharpless asymmetric epoxidation, Skraup synthesis.

Unit -V

Oxidation – Jone's reagent, Pyridinium chlorochromate (PCC), Pyridinium dichromate (PDC), Chromyl chloride, Dicyclohexylcarbodiamide (DCC), DMSO, DMSO-Ac_2O, DMSO-oxalyl chloride (Swern reaction), Oppenaur oxidation, Sommelet reaction - oxidative cleavage of 1, 2 – diols (lead tetra acetate and periodic acid), Etard reaction, Dichlorodicyanobenzoquinone (DDQ), SeO_2, ozonolysis, allylic oxidation (SeO_2 & NBS)

Reduction – catalytic hydrogenation – typical reactions – catalysts and solvents, catalytic dehydrogenation.

Metal hydride reduction – typical reactions and conditions used – $LiAlH_4$, $NaBH_4$ and $NaCNBH_3$ reductions, hydroboration, 9BBN, tri –n- butyl tinhydride (TBH), DIBAL–H, Me_3SiCN, tri tertiarybutoxy aluminum hydride, stereochemistry of reduction of cyclic ketones with metal hydrides. Dissolving metal reductions – Birch reduction, Clemmensen reduction, Wolff-Kishner, Meerwein-Pondorff-Verley and Rosenmund reduction, McMurrays coupling, cannizzaro reaction, acyloin condensation, Wilkinson's catalyst.

References

1. Advanced organic chemistry - Reactions, mechanism and structure. Jerry March, Mc Graw Hill Kogakusha Ltd., 1977.
2. Mechanism and Theory in Organic Chemistry, Lowry and Richardson, Harper & Row Publishers, New York 1981.
3. Reactions mechanisms in organic chemistry, Mukergee and S. P. Singh, Mc Millan 1976.
4. Organic Chemistry, Vol-I, I. L. Finar, Longmans, 1963.
5. Advanced Organic Chemistry. Jagdamba Singh and L.D.S.Yadav, Pragati Prakasan, 2011-12.
6. Organic Synthesis, 7th Edition, Jagdamba Singh and L.D.S. Yadav, Pragati Prakasan, 2011.
7. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge University Press, 1971.
8. Principles of Organic Synthesis, Norman, John Wiley & Sons, 1973.
9. Guidebook to Organic Synthesis, R. K. Mackie and D. M. Smith, Longman, 1982.

Course Code and Title : 13H – Biochemistry

Course Type : Core (for Biotechnology) Semester : I Credits: 4

Scope: This paper presents the study of identification and quantitative determination of the substances, studies of their structure, determining how they are synthesized metabolized and degraded in organisms, and elucidating their role in the operation of the organism.
Objective: On the successful completion of the course the students will get an overall understanding of structure of atoms, molecules and chemical bonds, enzyme kinetics, bio polymers and metabolic reactions in a living system.
Goal: This paper in biochemistry has been designed to provide the student with a firm foundation in the biochemical aspects of cellular functions which forms a base for their future research.

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 (6th Ed.) – J.M Berg; J.L.Tymoczko and L.Stryer, W H Freeman and Company, NY.

Course Code and Title : 13C – Quantum Mechanics

Course Type : Core (for Physics) **Semester : I** **Credits: 4**

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 J_z with J_+ and J_- - Eigen values of J^2, J_z-

Matrix representation of J^2, J_z, 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.

References

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

Course Code and Title : 13F – Inorganic Chemistry - I

Course Type : Core **Semester : I** **Credits: 4**

Unit-I

Homocyclic and Heterocyclic Ring Compounds - Borazines, phosphonitrilic compounds, sulphur-nitrogen compounds, organohalosilanes, silanols, siloxanes, silylamines (silazenes) Isopoly and heteropoly acids of vanadium, chromium, molybdenum and tungsten

Unit -II

Reactions in Non-aqueous Solvents: Classification of solvents – properties of ionizing solvents – a general study of the typical reactions in liquid ammonia, sulphur dioxide, anhydrous hydrogen fluoride, hydrogen sulphide and hydrogen cyanide – a comparative study, organophosphorus compounds, alkyllithium compounds.

Acids and Bases - Lowry-Bronsted theory-Lewis concept– Hardness and softness of acids and bases.

Unit-III

Nuclear Chemistry - The nucleus – subatomic particles and their properties – binding energy-n:p ratios in stable and metastable nuclei – Different types of nuclear forces – Liquid drop model and Shell model.

Modes of radioactive decay – Theory of alpha decay, beta decay and gamma radiation.

Orbital electron capture, nuclear isomerism – Internal conversion.

Unit-IV

Experimental Methods - Cloud chamber, nuclear emulsion, bubble chamber, proportional counters, G M counter, Scintillation and Cherenkov counters

Particle Accelerators - Linear accelerators – cyclotron, synchrotron, Betatron and Bevatron.

Unit-V

Nuclear Reactions - Q – value, coulombic barrier – nuclear cross section – different types of nuclear reactions- projectile capture – particle emission, spallation, fission and fusion – Product distributions – theories of fission, use of fission products, fissile and fertile isotopes- U-233, U-235, Pu-239, Th-232 – Stellar energy – Synthesis of new elements.

Radio Isotopes - Applications – isotopes as tracers – neutron activation analysis and isotopic dilution analysis – uses in structure and mechanistic studies – carbon dating

References

1. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, C. A. Murillo, M. Bochmann, John Wiley & Sons, VI Edition, 2003-04.
2. Modern Aspects of Inorganic Chemistry, H. J. Emeleus and A. G. Sharpe, John Wiley & Sons, 1973.
3. Source book on Atomic Energy, S. Glasstone, Krieger Pub. Co., 1979.
4. Advanced Inorganic Chemistry, Gurdeep Raj and Mehra Harish, Goel Publishing House, 1976.
5. Chemistry in Non-aqueous solvents, Harry H. Sisler, Reinhold, 1961
6. Nuclear and Radiochemistry, G. Friedlander, J. W. Kennedy and J. M. Miller, John Wiley, 1964.
7. Inorganic Chemistry, J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi, Pearson Education Inc., 1993.

Course Code and Title : 13I – Microbiology

Course Type : Core (for Biotechnology) **Semester : I** **Credits: 4**

Unit - I

History of Microbiology- History of Microbiology. Principles of classification of microbes; morphological, metabolic and molecular criteria for the classification, A brief introduction to major group of bacteria. Ultra structure of bacteria.

Unit -II

Microbial Cultivation- Nutritional types requirements of bacteria. Cultivation of bacteria: Pure culture techniques different media. Culture media and preparation:- Preservation of cultures aerobic and anaerobic culture techniques. Batch and synchronous cultures. Growth curve and factors influencing growth

Unit - III

Control of Microbial growth- Principles and techniques:- Physical and Chemical methods. Disinfection- Method of action of disinfectants. Methods of testing disinfectants.

Unit IV

Microbial physiology- Staining characteristics, Gram staining, AFB staining, florescent staining, serological characteristics:- surface antigen, capsular antigen & flagellar antigen,

Cultural characteristics, Photosynthetic microorganisms, cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Bacterial aerobic respiration, Bacterial anaerobic respiration: introduction. Nitrate, carbonate and sulfate as electron acceptors. Electron transport chains in some anaerobic bacteria. Mechanism of oxygen toxicity. Bacterial transport system-ABC, Sec pathway, PTS, role of permeases in transport, different permeases in E. coli.

Unit V

Microbial Diversity- General properties of fungi, fungal classification, economic importance of fungi, Mycoplasma, Actinomycetes, Archebacteria (extremophiles) and microbial algae.

References

1. Microbial Physiology and Metabolism by Caldwell D.R. 1995Brown Publishers.
2. Microbial Physiology by Moat A.G. and Foster J. W. 1999.. Wiley.
3. Prokaryotic Development by Brun. Y.V. and Shimkets L.J. 2000. ASM Press.
4. Advances in Microbial Physiology. Volumes. Edited by By A.H. Rose. Academic Press, New York.
5. Applied Microbial Physiology by Rhodes.
6. Principles of bacteriology, virology and immunology Vol I Topley and Wilson
7. Zinser, Microbiology
8. Microbiology , Prescottt, Harley and klien
9. Foundations in Microbiology Talaro and Talaro
10. Text book of Microbiology, R Ananthanarayanan C K J Panicker
11. Microbiology, Pelczar, Chan and Kreig.

Course Code and Title : 13D – Mathematical Physics

Course Type : Core (for Physics) **Semester : I** **Credits: 4**

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 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

References

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.
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.

Course Code and Title : 13G – Physical Chemistry - I

Course Type : Core (for Chemistry) **Semester : I** **Credits: 4**

Unit-I

Molecular symmetry and group theory – Point symmetry – Schonfloes and Herman-Mauguin notations – identification of point groups of simple molecules – postulates of group theory – group multiplication table – orthogonality and irreducible representations – application of the orthogonality theorem to obtain the irreducible representations of the point groups C_{2v} and C_{3v} only – character table (explanation) different areas of the character tables.

Unit-II

Application of the group theoretical methods to find the total number of vibrations of simple molecules such as H_2O and NH_3 – Selection rules with regard to Raman and IR activities and electronic transitions – splitting of orbitals in O_h, T_d and D_{4h} symmetries – hybridization as applied to methane and water – simplification of MO calculations employing symmetry adopted linear combination molecular orbital procedure – application to butadiene.

Unit-III

Chemical Kinetics - The ARRT – thermodynamic treatment of ARRT – significance of reaction co-ordinate – application of ARRT – Unimolecular and bimolecular processes – potential energy surface – Kinetic isotopic effect – Principles of microscopic reversibility –

Steady State Approximation – third order and termolecular reactions – Applications of ARRT to solution kinetics – Factors affecting reaction rates in solution.
Chain reactions and explosions – Homogeneous catalysis, Acid – base catalysis – salt effects – acidity functions – Zucker-Hammet hypothesis – Bunnett criterion.

Unit-IV

Enzyme catalysis – Mechanism of single substrate reaction – influence of P^H and temperature – fast reactions – Kinetics of polymerization in solution – Heterogeneous catalysis – adsorption and free energy relation at interfaces – Gibbs adsorption isotherm – Physical adsorption – Chemisorption – Potential energy diagram and Lennard-Jones plots – Langmuir and BET isotherms – Measurement of surface area – Semiconductor catalysis – Langmuir – Hinshelwood and Langmuir – Rideal – Eley mechanisms

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. F. A. Cotton, Chemical Applications of Group Theory
2. Ramakrishnan and Gobinathan, Group Theory in Chemistry
3. Raman, Group Theory
4. K.J. Laidler, Chemical Kinetics, Tata McGraw Hill
5. Gurdeep Raj, Chemical Kinetics, Goel Publishing House.
6. P.W.Atkins, Physical Chemistry
7. W.J.Moore, Physical Chemistry, Longmans
8. A.A.Frost and R.G.Pearson, Kinetics and Mechanism, Wiley Eastern, Pvt. Ltd.

Course Code and Title : 13J – Cell and Molecular Biology

Course Type : Core (for Biotechnology) **Semester : I** **Credits: 4**

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

Course Code and Title : 1EA – Analog and Digital Electronics

Course Type : Elective (for Physics) **Semester : I** **Credits: 4**

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.

References

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.

Course Code and Title : 1EB – Analytical Chemistry

Course Type : Elective (for Chemistry) **Semester : I** **Credits: 4**

Unit-I

Mass Spectrometry-Theory – Instrumentation – Isotopic abundance – Double bond and ring equivalence - Determination of molecular weights and formulae, Ionisation techniques(CI, FD, FAB &ESI) – Nitrogen rule – Metastable ions and peaks – Ion fragmentation mechanisms – Retro Diels-Alder rearrangement – Mclafferty rearrangement – Fragmentation associated with functional groups – aliphatic and aromatic compounds – Elimination due to ortho groups.

Unit-II

Chromatography – Principles, theory, instrumentation and applications in chemical analysis of the following – column, paper, thin layer and ion-exchange – GC, GLC and HPLC. Purification of common organic solvents.

Atomic absorption spectroscopy and Flame emission spectroscopy – basic principles – Instrumentation and applications.

Unit-III

Metallic State- Free electron, band and zone theories-non-stoichiometry – point defects in solids- Schottky and Frenkel defects – linear effects – dislocation – effects due to dislocation – electrical properties of solids – insulators – intrinsic semiconductors (n & p type) and super conductors, ceramics (elementary treatment).

Chemical Crystallography – Diffraction methods – X-ray , neutron and electron Diffraction – Structure of NaCl , KCl and CsCl – Determination of lattice type and unit Cell dimensions – Power Camera – indexing the powder pattern – An elementary discussion of structural factors and scattering factor – Structures of rutile , fluorite , Antifluorite , zinc blende ,wurtzite , diamond and graphite.

Unit -IV

Poarimetry – Circular Dichroism and Optical rotatory dispersion –Basic principles of ORD and CD – Cotton effects – Octant rule – axial halo ketone rules - applications of ORD and CD

Mössbauer Spectroscopy - principles – Spectrometer – Isomer shift – Quadruple interaction – Nuclear Zeeman Splitting – Applications.

Unit-V

Green Chemistry Principles - Definition, need of green chemistry, twelve basic principles of green chemistry-planning a green synthesis in a chemical laboratory- solvent-less reactions, selection of appropriate solvent, use of microwaves-fundamentals of closed-vessel heating and sonication. Atom efficient processes and atom efficiency, atom economy (with specific reaction).

Greener Reactions – Water as greener solvent- reactions in ionic-liquid, solvent free reaction-solid supported organic synthesis, phase transfer catalyst (PTC), use of microwaves and sonication (any four specific reactions with mechanism).

References

1. Silverstein and Webster, Spectrometric Identification of Organic Compounds
2. W. Kemp, Organic Spectroscopy
3. Analytical Chemistry, Gary D. Christian, 5th Edition, John-Wiley & Sons, Inc, 1994.

4. Principles of Instrumental Analysis, D. A. Skoog & D. M. West, Holt Reinhart Winston, 1988.
5. Chemical Analysis, K. A. Robinsons, Harper Collins Publishers, 1987.
6. Solid State Chemistry, Arora
7. Solid State Chemistry, Alberty and Silbey
8. Vogel's Text Book of quantitative Inorganic Analysis, J. Basset, R. C. Denny, C. H. Jaffery and J. Mendhan, 5th Edition, ELBS, 1989.
9. Instrumental methods of Analysis, H. A. Willard, L. L. Merrit, J. A. Dean, Van Nostrand, 1986.
10. Instrumental Methods of Chemical Analysis, Ewing
11. Eliel, Stereochemistry of Carbon compounds, McGraw-Hill
12. Finar I.L Organic Chemistry Vol II
13. Physical methods in Inorganic Chemistry, Drago.
14. Green Chemistry, V.K.Ahluwalia.
15. Green Chemistry, P.T. Anastas and J. C. Warner, 1998
16. Green Chemistry, S. Delvin

Course Code and Title : 1EC – Biostatistics

Course Type : Elective (for Biotechnology) **Semester : I** **Credits: 4**

Scope: This paper highlights on vital statistical techniques for analysis of biological data.
Objective: To expose students to various statistical technique and bio statistical tools used in modern biology and biotechnology research.
Goal: Upon successful completion of the paper the students will get an insight on the usage of various statistical tools and their relevant applications.

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.

Course Code and Title : 23A – Synthesis and Fabrication of Nanomaterials

Course Type :Core **Semester : II** **Credits: 4**

Unit-I - Chemical Methods

Sol-Gel Process - Self assembly - Electrodeposition - Spray Pyrolysis - Flame Pyrolysis – Metal Nanocrystals by Reduction - Solvothermal Synthesis - Photochemical Synthesis - Sonochemical Routes – Reverse Micelles and Micro emulsions - Combustion Method – Template Process - Chemical Vapor Deposition (CVD) – Metal Orgonic Chemical Vapor Deposition (MOCVD)

Unit-II - Physical Methods

Ball Milling - Inert Gas Condensation Technique (IGCT) – Thermal evaporation – Pulsed Laser Deposition (PLD) – DC/RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE) – Melt Spinning process - IC Fabrication Process – Microlithography – Etching – Wet Cleaning – CMP – Backend Process.

Unit-III - Biological Synthesis

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.

Unit-IV Nanocomposites

Ceramic/Metal Nanocomposites - Metal Matrix Nanocomposites - Nanocomposites for Hard Coatings – Polymer based nanocomposites – nanoscale fillers – processing of polymer nanocomposites – Properties of polymer nanocomposites. Core-Shell structured nanocomposites - morphology and fractal model of hybrid nanocomposites – intercalation process – polymerization into the basal space – macromolecules introduction into the layered host lattices – Langmuir-Blodgett metallopolymers films as self-organized hybrid nanocomposites

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.

Course Code and Title : 23B – Properties of Nanomaterials

Course Type :Core **Semester : II** **Credits: 4**

Scope: This course will give an information about the properties of materials at the nano scale and also a comparision with its bulk counter parts.

Objectives: An understanding of the structure-property relationships at nanoscale as well as the concepts, a thorough knowledge on various properties and critical evaluation of the promising nanotechnology devices.

Goal: This course aims to correlate the properties associated with the size and structure control.

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 - Nanophotonics

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.

References

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

Course Code and Title : 23C – Statistical Mechanics and Thermodynamics

Course Type : Core (for Physics) Semester : II Credits: 4

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

References

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}.

Course Code and Title : 23E – Organic Chemistry - II

Course Type :Core (for Chemistry) **Semester : II** **Credits: 4**

Scope: This course presents the comprehensive chemistry of natural products, terpenoids, proteins and stereochemistry
Objectives: On successful completion of the course the students should have versatile knowledge in isolation, synthesis, bio- synthesis and elucidation of various natural products, conformational analysis and stereochemistry.
Goal: To enable the students to learn the synthesis and isolation of natural products and heterocyclic compounds.

Unit-I

Organic Photochemistry - Theory of light absorption –electronic excitation - properties & energies of excited states – Jablonski diagram – photo physical processes - fluorescence and phosphorescene - excimers and exciplexes – intersystem crossing – energy transfer - geometry of excited states - quantum efficiency.
Photochemical reactions of ketones – Norrish Type I, Norrish Type II – Paterno – Buchi reaction – Photo reduction and oxidation – α, β- unsaturated ketones- Photochemistry of olefins, conjugated olefins and aromatic compounds – *cis-trans* isomerisation - di – π methane rearrangement of cyclohexdienones – Barton's reaction.

Unit–II

Pericyclic Reactions – Characteristics – Electrocyclic reactions of 1, 3-dienes and 1, 3, 5-trienes.[2+2] and [4+2]cycloadditions - The Frontier Molecular Orbital approach (FMO) and Correlation diagrams – The Woodward – Hoffmann rules. 1,3 – diploar addition – Cheleotropic reaction.
Sigmatropic reactions – [1, 3], [1, 5] and [3, 3] Sigmatropic shifts, Frontier Molecular Orbital approach – Claisen and Cope rearrangements, ene reactions.
Theories –Huckel – Mobius approach, Dewar – Zimmermann Approach.

Unit-III

Addition Reactions to Carbonyl Compounds - Mannich, Aldol, Grignard, Claisen & Dieckmann, Stobbe, Perkin, Knoevenagel, Darzen, Wittig, Thorpe, Reformatsky and Benzoin reactions, Friedlander quinoline synthesis, Strecker and Peterson synthesis. Stereo selectivity in carbonyl addition reactions - Cram's rule.

Unit-IV

Molecular Rearrangements – Wagner – Meerwein rearrangement – Migratory aptitudes-Memory effects – Demyanov, Neber, Baeyer–Villiger, Dienone – phenol, Favorski, Fries and Benzidine, Wolff, Steven's, Lossen and Schmidt rearrangements – Non-cyclic rearrangements – Chapman and Wallach rearrangement, Arndt-Eistert synthesis, Fischer Indole synthesis.

Unit-V

Stereochemistry: Optical isomerism – concept of chirality- stereochemistry of sulfur and nitrogen compounds – concept of prochirality- enantiotopic and diastereotopic ligands & faces- stereo selective and stereo specific reactions - R, S – nomenclature of compounds having one and more than one chiral centres – axial chirality - (optical isomerism of biphenyls, allenes and spirans)- planar chirality (optical isomerism of ansa compounds and cyclophanes) - helicity (optical isomerism of over – crowded molecules)

Geometrical Isomerism – E, Z – notation – Determination of configuration of geometrical isomers- stereoismerism of cycilc compounds (up to six membered ring)– aldoximes & ketoximes.
Conformational Analysis - configuration and conformation – Conformation of acyclic compounds – cyclohexanes, decalins – stability and reactivity in relation to conformation – perhydrophenanthrenes

References

1. Eliel, Stereochemistry of Carbon compounds
2. Eliel, Allinger, Angyal and Morrison, Conformational Analysis
3. Jerry March, Advanced Organic Chemistry
4. DE Mayo, Molecular Rearrangements
5. Stevens and Watts, Selected Molecular Rearrangements
6. Nasipuri, Stereochemistry of Organic Compounds
7. Turro, Molecular Photochemistry
8. Deputy and Chapman, Molecular reactions and Photochemistry
9. Rohatgi Mukherjee, Fundamentals of Photochemistry
10. Jaffee and Orchin, Orbital Symmetry
11. Cowan and Drisko, Elements of Organic Photochemistry
12. Coxon and Halton, Organic Photochemistry
13. Jagdamba Singh and L.D.S. Yadav, Advanced Organic Chemistry
14. Mukherji and Singh, Reaction Mechanism in Organic Chemistry

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Course Code and Title : 23G – Immunology

Course Type :Core (for Biotechnology) **Semester : II** **Credits: 4**

Unit-I

Immune System- Introduction to immunology, infections. Organs and cells involved in immune system. Lymphocytes, their subpopulation, their properties and functions, membrane bound receptors.

Unit-II

Antigens and Immunoglobulins- Concept of haptens, determinants, conditions of antigenicity, antigens and immunogenecity, superantigen. Immunoglobulins: Structure and properties of immunoglobulin classes. Clonal selection theory, hybridoma technology for monoclonal antibodies and designer monoclonal antibodies. Structural basis of antibody diversity. Freund's adjuvants and its significance.

Unit-III

Antigen – Antibody reactions- Antigen-Antibody reaction by precipitation, agglutination and complement fixation. Complement system: Classical, alternate, lectin pathway of complement activation. Non-specific immune mechanism: - Surface defenses, tissue defenses, opsonization, inflammatory reaction. Tissue metabolites with bactericidal properties (lysozyme, nuclein, histone, protamine, basic peptides of tissues – leukins, phagocytins, lecterins, haemocompounds).

Unit-IV

Expressions of Immune Response- Antigen processing and presentation, MHC restriction, generation of humoral and cell mediated immune response, maturation and activation of B and T lymphocytes, cytokines and their role in immune regulation, Immunological tolerance

& regulation. Cell mediated cytotoxicity: Mechanism of T cells and NK cell mediated lysis, ADCC and macrophage mediated cytotoxicity.

Unit V

Immunity in Medical biology- Transplantation immunology: MHC, typing, types of grafts, grafts rejection, GVH reactions, mechanism of graft rejection, and prevention of graft rejection. Immuno deficiencies and autoimmunity. Hypersensitivity, Tumor immunology, immune hematology – ABO, Rh, and Duffy systems, transfusion reactions, Immune response against parasitic and viral infection.

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. Fundamental immunology, Paul w e (ed)
2. Principles of bacteriology, virology and immunity Vol I Topley and Wilson.
3. Essential clinical immunology- Helen chappu and Mansel haeny
4. Introduction to immunology John w Kimball
5. Textbook of microbiology, Ananthanarayanan and Jayaram paicker.
6. Essential immunology Roitt
7. Basic and clinical immunology stiles, Stobo,Fuden berg wells (eds)
8. Microbiology and immunology David J Hantges

Course Code and Title : 23D – Nuclear and Particle Physics

Course Type :Core (for Physics) Semester : II Credits: 4

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.

Course Code and Title : 23F – Physical Chemistry - II

Course Type :Core (for Chemistry) **Semester : II** **Credits: 4**

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

Calculation of heat of solvation, hydration of ionic species – Ionic strength – concentration and activity coefficient – Debye-Huckel limiting law- Electrochemical Method of determining activity coefficients of electrolytic solutions – Electrolytic conductances – Debye-Huckel-Onsager equation – verification – Wien effect and Debye-Falkenhagen effect – Thermodynamics of electrochemical reactions – Free energy and emf – Standard and formal electrode potentials – Problems based on electrode potentials and their measurements – Ion selective electrodes.

Unit-V

Electrode – Electrolytic interface – electrical double layer – electrocapillary thermodynamics – Lippman equation – Measurements of double layer capacitances – Theoretical models of double layers – Helmholtz and Guoy-Chapman models – Potential of zero charge – Stern model – outer and inner Helmholtz planes – Specific adsorption of cations, anions and neutral molecules – a brief outline of electrokinetic phenomenon and memberane potentials.

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.
9. Bockris and Reddy, Modern Electrochemistry (Vol. I & II)

Course Code and Title : 23H – Pharmaceutical Biotechnology

Course Type :Core (for Biotechnology) Semester : II Credits: 4

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 and 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.

Course Code and Title : 2EA – Advanced Materials Science

Course Type :Elective (for Physics and Chemistry) Semester : II Credits: 4

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.

References

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 x 10^{23} arsenic atoms and 5 x 10^{23} atoms of boron. Determine the electron and hole concentrations if the intrinsic charge carriers of silicon are 2 x 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 x 10^{-39} Fm^2 at 309 K and 2 x 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 x 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?

Course Code and Title : 2EB – Environmental Biotechnology

Course Type : Elective (for Biotechnology) **Semester : II** **Credits: 4**

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). 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.

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

Sustainable Nanotechnology: Application of industrial ecology to nanotechnology, Fate of nanomaterials in environment, environmental life cycle of nano materials, environmental and health impacts of nano materials, toxicological threats, eco-toxicology, exposure to nano particles – biological damage, threat posed by nano materials to humans, environmental reconnaissance and surveillance. Corporate social responsibility for nanotechnology, Nano materials in future - implications.

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.
12. Enviro-nanotechnology by Mao Hong fan, Chin-pao Huang, Alan E Bland, Z Honglin Wang, Rachid Sliman, Ian Wright. Elsevier, 2010.
13. Nanotechnologies, Hazards and Resource efficiency by M. Steinfeldt, Avon Gleich, U. Petschow, R. Haum. Springer, 2007.
14. Nanotechnlogy: Health and Environmental risk by Jo Anne Shatkin. CRC press, 2008.

Course Code and Title : 23P – Practical - I

Course Type : Practical **Semester** : II **Credits**: **4**

First Half

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. Separation of peripheral mononuclear cells from the blood.
16. Hematology: RBC and WBC total counts

Second Half

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

Course Code and Title : 33A – Modern Instrumental Methods for Materials Analysis

Course Type :Core **Semester : III** **Credits**: **4**

Unit-I

*Structural Characterization***:** X-ray diffraction – Bragg's law - Scherer formula – dislocation density – micro strain, Neutron Diffraction – Principle – Applications - comparison of X-ray and neutron powder pattern - Synchrotron Radiation – Principle and Applications – FTIR and Raman Spectroscopy - Applications – Dynamic Light Scattering (DLS).

Unit-II

*Microscopic and Elemental Analysis***:** Electron microscopes : scanning electron microscope (SEM) – transmission electron microscope (TEM) –; Scanning Probe Microscopy - atomic force microscope (AFM) – scanning tunnelling microscope (STM); Laser Confocal Microscope.

Unit-III

*Spectroscopy***:** X-ray photoelectron spectroscopy (XPS) – EDAX and WDA analysis - Mass Spectrometer – Secondary Ion Mass Spectrometer (SIMS) - Working Principle, Instrumentation and Applications; Nuclera Techniques: Nuclear Magnetic Resonance (NMR) – Electron Spin resonance (ESR) – Mössbauer spectroscopy.

Unit–IV

*Electrical, Mechanical and Magnetic Properties***:** Impedance Spectroscopy – Electroanalytical Techniques: Potentiometry – Voltametry Cyclic Voltametry - Physical Property Measurement System (PPMS) – Measurement of – Nanoindentation – Principle – Elastic and Plastic Deformation – Nanoindenation data analysis - micro hardness - fatigue - failure stress and strain toughness – abrasion and wear resistance, super plasticity – vibrating sample magnetometer

Unit–V

Thermal and Optical Properties: Differential scanning calorimeter (DSC) – Thermogravimetric/Diffferential Thermal Analyzer (TG/DTA) – UV – Visible Spectrophotometer – Principle and Applications – Photoluminescence (PL) Spectroscopy.

References

1. Encyclopedia of Materials Characterization, C. Richard Brundle, Charles A. Evans Jr., Shaun Wilson, Butterworth-Heinemann Publishers (1992).
2. Handbook of Microscopy for Nanotechnology, Ed. By Nan Yao and Zhong Lin Wang, Kluwer Academic Press (2005).

3. Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Guozhong Gao, Imperial College Press (2004).
4. Nanotechnology - Enabled Sensors, Kourosh Kalantar-zadeh and Benjamin Fry, Springer (2008).
5. Nanochemistry, G. B. Sergeev, Elsevier (2006).
6. Nanotechnology: Basic Science and Emerging Technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press (2005).
7. Nanocomposite Science and Technology, Pulickel M.Ajayan, Linda S.Schadler, Paul V.Braun, Wiley-VCH Verlag, Weinheim (2003).

Course Code and Title : 33B – Nanobiotechnology

Course Type :Core **Semester : III** **Credits: 4**

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 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.

References

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

Course Code and Title : 33C – Micro and Nanofabrication

Course Type :Core **Semester : III** **Credits: 4**

Unit-I - Microfabrication

Moores law - Optical lithography – Working principle – Limitations – E-beam lithography – Working principles – limitations – Resist used for lithography and their types - Properties of resist - Wet Etching – Dry Etching – Substrate Bonding : Si Direct Bonding – Anodic Bonding – Bonding with Intermediate Layers – bulk micromachining – surface micromachining

Unit-II - Micro and Nanofabrication Techniques

UV lithography – Extreme UV (EUV) lithography – X-ray lithography –soft contact lithography (micromoulding) - Nano-Imprint lithography – Nanostencil lithography – Ion beam lithography – dip pen lithography - scanning probe lithography – near field optical lithography – local oxidation by AFM - 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 - MEMS and NEMS Devices

Pressure sensor, Accelerometers, gyroscopes, micropumps for lab on chip devices, glucose sensors, electrochemical gas sensors, optochemical gas sensors, valves, field emission displays.

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.

References

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

Course Code and Title : 33D – Electromagnetic Theory

Course Type :Core (for Physics) **Semester : III** **Credits: 4**

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

References

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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Course Code and Title : 33E – Inorganic Chemistry - II

Course Type :Core (for Chemistry) **Semester : III** **Credits: 4**

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

Metal carbonyls, methods of preparation, structure, bonding, IR spectra and reactions – carboxylate ions – carbonyl hydrates, carbonyl halides – Vaska's compound – compounds of molecular nitrogen and oxygen – Nitrosyl complexes, β-diketones, cyanide and isocyanide complexes – complexes of unsaturated hydrocarbons alkenes, allyls and dienyls.

Unit-IV

*Carbocyclic π –Complexes***:** Cyclopentadienyl and related complexes (synthesis, bonding, structure and reactions) – Arene complexes : Complexes formed by seven and eight membered aromatic rings.

*Complexes of Biochemical Importances***:** Cytochromes, haemoglobin, myoglobin, cyanocobalamine, chlorophyll (structure and functions), sodium ion pump-metal poisons and chelating agents in medicine.

Unit-V

*Reactions of Co-ordination Compounds***:** Ligand substitution reaction in octahedral complexes – mechanism of nucleophilic substitution reaction in octahedral and square planar complexes – Trans effect – Theories – electron transfer reactions in co-ordination compounds – theory of redox reactions.

Homogenous Catalysis of Co-ordination Compounds: Hydroformylation, Carbonylation of methanol and methylacetate, Hydrogenation of unsaturated organic compounds , Wacker process – Ziegler- Natta polymerization.

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
4. J.D.Lee, Inorganic Chemistry

Course Code and Title : 33F – Toxicology

Course Type :Core (for Biotechnology) Semester : III Credits: 4

Unit-I

Introduction to Toxicology-Definition, scope and different branches of toxicology, Spectrum of toxic doses, Classification of toxic agents, Characteristic of exposure, Spectrum of undesired effects, Interaction of chemicals and their toxic effect, tolerance, Dose-Response relationship- Graded and Quantal response, Hormesis, Assumption and evaluation of dose response relationship, Variation in toxic responses.

Unit-II

Measuring toxicities- Toxicity testing methods, The LD50 Experiment, Acute, Short-Term and Chronic toxicities and its manifestations: Mode of application, administration, exposure and *invitro* tests. Disposition of toxicants- Absorption, Distribution, Metabolism and Excretion (ADME) of toxicants and chemicals, Xenobiotic Biotransformation by Phase I (Hydrolysis, Oxidation, and Reduction) and Phase II (Glucuronidation, Sulfation, Acetylation, Methylation and Conjugation reactions).

Unit-III

Mechanism of toxicity- Delivery of the toxicant, Concept of ultimate toxicant, Reaction of the ultimate toxicants. Toxic agents, Toxic effects of metals: Mercury, Lead, Arsenic, Fluoride; Source, exposure, absorption, target site interaction and health hazards. Toxic effects of pesticides: Brief classification with examples; Residual and non-residual pesticides; Mode of entry and mode of action of pesticides in target and non-target organisms.

Unit-IV

Toxic effects of solvents and vapours: Solvent-induced chronic encephalopathy, solvent abuse, Chlorinated hydrocarbons, fuel and fuel additives, Ecological Toxicology, Ecotoxicology: Chemical movement, fate and exposure; Biomarkers; Effects of toxicants at the population, community and ecosystem level, Examples of ecosystems and vulnerability to toxicants. Applications of Toxicology, Toxicologic investigation of a poison death, Therapeutic and Biological monitoring, Clinical Strategy for treatment of the Poisoned Patient.

Unit-V

Dosimetry, Epidemiology And Toxicology of Nanoparticles- Epidemiological Evidence for Health Effect Associations with Ambient Particulate Matter; Toxicological Evidence for Ambient Particulate Matter Induced Adverse Health Effects; Inhaled Nanoparticle Dosimetry; Toxicological Plausibility of Health Effects Caused by Nanoparticles;Integrated Concept of Risk Assessment of Nanoparticles.

References

1. Cassarett and Doull's Toxicology: The Basic Science of Poison by Curtis D. Klassen 7th Edition, McGraw Hill Publishers, 2007.
2. Cassarett and Doull's Essentials of Toxicology by Klassen and Whatkins, 1st Edition, McGraw Hill Publishers, 2003.
3. Principles of Toxicology by Karen E. Stine and Thomas M. Brown 2nd Edition, Taylor and Francis Publishers, 2006.
4. Lu's Basic Toxicology by Frank C. Lu and Sam Kacew 4th Edition. Taylor and Francis Publishers, 2002. Introduction to Toxicology by John Timbrell 3rd Edition, Taylor and

Francis, 2002.
5. Challa S. S. R. Kumar, Nanomaterials - Toxicity, Health and Environmental Issues, Wiley-VCH publisher (2006).
6. Nancy A. Monteiro-Riviere, C. Lang Tran, Nanotoxicology: Characterization, Dosing and Health Effects‖, Informa healthcare (2007).
7. D. Drobne, Nanotoxicology for safe and Sustainable Nanotechnology, Dominant publisher (2007).
8. M. Zafar Nyamadzi, A Reference handbook of nanotoxicology, Dominant publisher (2008).

Course Code and Title : 3EA – Nanodevices and Applications

Course Type :Elective **Semester : III** **Credits: 4**

Unit-I - Sensors

Sensors - Sensor Characteristics and Terminology - Static and Dynamic Characteristics; Organic and Inorganic Nanotechnology Enabled Sensors - Surface Interactions - Surface Materials and Surface Modification - Proteins in Nanotechnology Enabled Sensors Nanostructured Thin Films gas sensor - Nanotechnology Enabled Mechanical Sensors - Nanotechnology Enabled Optical Sensors - Magnetically Engineered Spintronic Sensors - Nano-sensors based on Nucleotides and DNA.

Unit-II - Energy Devices

Nanotechnology enabled Solar Cells - Band Diagram and Operational Principle of Nanocrystalline Solar Cells – Dye sensitized solar cells - 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 - Principles of Operation of Energy Conversion and Storage Devices - Lithium Ion Batteries - Fuel Cells - Photoelectrochemical Solar Cells - Electrochemical Double-Layer Capacitors – super capacitors

Unit-III - Biomedical Applications

Quantum Dots as Tracers for DNA Electrochemical Sensing Systems - 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 – Utilisation of Iron Oxide Nanoparticles in *in-vitro and in-vivo* Investigations - Magnetic Nanoparticles for Imaging and Therapy in Humans

Unit-IV - Electronics and Photonics applications

NanoLED, Photodetectors, accelerometer, gyroscope, DNA computer -Quantum computer - spintronic transistor – Magnetic nanoparticle based spintronic transistor – nanowire waveguide for optical processing – nanophotonic crystals – Nanoelectronic devices: Quantum dots – Resonant tunneling devies – single electron transistor – molecular electronics

Unit-V - Nanostructured Food and Packaging Materials

Naturally Occurring Food Nanosubstances and Nanostructures - Designing Food Nanostructures - 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.

References

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.
6. Recent Trends in Fuel Cell Science and Technology, Edited by Suddhasatwa Basu, Springer (2007).
7. Nanomedicine, Vijay K. Varadan, Linfeng Chen, Jining Xie, A John Wiley and Sons, Ltd., Publication (2008).
8. 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).

Course Code and Title : 33P – Practical - II

Course Type :Practical **Semester : III** **Credits: 4**

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

37V- MINI PROJECT AND STUDY TOUR

Course Code and Title : 43A – IPR and Biosafety

Course Type :Core (Self Study) **Semester : IV** **Credits: 2**

Unit-I

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP. Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation

Unit-II

Types of patents; Indian Patent Act 1970; Recent Amendments; Patent application- forms and guidelines, fee structure, time frames;Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement,procedures and costs; Financial assistance for patenting-introduction to existing schemes.

Unit-III

IPR policy of Government of India, Indian & International Patent laws, Indian Patent Act 1970; Recent Amendments; Financial assistance for patenting-introduction to existing schemes. Role of patents in Bbiotechnology. The patentability of microorganisms - IPR and WTO regime - consumer protection and plant genetic resources-GATT and TRIPS, Patenting gene. Issues and case studies.

Unit-IV

Biosafety- Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India;

Unit-V

Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk

Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

References

1. P. Narayanan, Intellectual Property Laws, Eastern Law House.2001
2. Meenu Paul, Intellectual Property Laws, Allahabad Law Agency.2009
3. Intellectual Property Law containing Acts and Rules, Universal Law Publication Company.
4. John E. Smith, Biotechnology,3rd Ed.Cambridge University Press.

47V- PROJECT AND VIVA VOCE
