BHARATHIAR UNIVERSITY, COIMBATORE 641 046
UNIVERSITY DEPARTMENT
M.Sc., NANOSCIENCE AND TECHNOLOGY
(For the candidates admitted from the academic year 2018-19 onwards)
Overview, Curriculum and Syllabus

Duration: 2 Years
Level: Post-Graduation
Type: PG. Degree
Eligibility: Any undergraduate Science Degree recognized by UGC

VISION: To achieve excellence in the field of Nanoscience and Technology through academic and research programmes and to participate in the interdisciplinary programmes offered in the University.

MISSION: As a Department, We are committed to,

- Provide knowledge and skill in Nanoscience and Technology through post-graduate and doctoral programmes.
- Undertake research in emerging areas of physical, chemical and biological sciences with nanoscience and technology and transform the findings for the benefit of the society.
- Solve the environmental issues through the post graduate and research programmes.
- Provide required knowledge in physical, chemical and biological sciences to understand nanoscience and technology for research.

Programme Educational Objectives(PEOs)

I. To prepare students to outshine in academics and research in different motifs of Nanoscience and Nanotechnology through post graduate education.
II. To provide students with a solid foundation in their respective core subjects such as Physics, Chemistry and Biotechnology in addition to Nanoscience and Technology.
III. To provide students with in-depth knowledge in Synthesis and Characterization of novel nanomaterials with multiple applications.
IV. To train students with good theoretical and practical knowledge so as to comprehend, analyze, design, and create products and solutions for the real life problems.
V. To instruct students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate nanotechnology to address biomedical applications and environmental issues.
VI. To provide students with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career.

PROGRAMME OUTCOMES (POs): On successful completion of the M.Sc. Nanoscience and Technology programme:

1. The Post Graduates will demonstrate knowledge on the physics/ chemistry/biotechnology and basics of nanoscale science and technology for their multifunctional applications.

2. Post Graduates will demonstrate an ability to synthesis and characterize the nanomaterials.
3. Post Graduates will project their skill in Lithography and nanofabrication.
4. Post Graduates will have expertise in processing of nanomaterials, MEMS and bio MEMS as per needs and specifications.
5. Post Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks including material science, physics, chemistry and nanobiotechnology.
6. Post Graduates will demonstrate skills to use synthesis, processing and imaging equipments to analyze samples.
7. Post Graduates will be able to propagate their knowledge to address problems of social relevance such as energy, environment and medicine through their specific electives.
8. Post Graduates will show the understanding of impact of nanomaterials on the society including environment, health and ecosystem.
9. Post graduates will be able to plan and execute their own innovative ideas in the form of projects, product design and development.
10. Post Graduates will develop confidence for self-education and ability for life-long learning.

Career Opportunities: M.Sc. Nanoscience and Technology graduates have plethora job opportunities in the following fields;

- Research Scientist and formulation scientist
- Nanomaterial Product developer
- Government agencies for regulatory monitoring
- Patent examiner
- Entrepreneurship
- Consultancy organizations in pharmaceuticals, Energy, Material Science, Medical, Agriculture, Environment Protection.
- Job in Scientific Research Organizations.
- Enroll for higher degree through research in India or abroad
- Healthcare industry

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UNIVERSITY DEPARTMENT
M.Sc., NANOSCIENCE AND TECHNOLOGY
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SCHEME OF EXAMINATION-(CBCSPATTERN)

Sem	Paper		Subject	Credit
I	Core-I		Fundamentals of Nanoscale Science and Technology	4
	Core-2	P	Classical Mechanics	4
		C	Organic Chemistry – I	4
		B	Biochemistry	4
	Core-3	P	Quantum Mechanics	4
		C	Inorganic Chemistry – I	4
		B	Microbiology	4
	Core-4	P	Mathematical Physics	4
		C	Physical Chemistry – I	4
		B	Cell and Molecular Biology	4
	Elective-1		Analog and Digital Electronics	4
			Analytical Chemistry	4
			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	4
		B	Immunology	4
	Core-8	P	Nuclear and Particle Physics	4
		C	Physical Chemistry – II	4
		B	Pharmaceutical Biotechnology	4
	Elective-2		Advanced Materials Science / Environmental Biotechnology	4
	Core-9		Practical-I	4
	Supportive-2		Offered from other Department	2
	Online Course-1		Online Course from Swayam, MOOC, NPTEL *etc.*	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	4
		B	Toxicology	4
	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
	Online Course-2		Online Course from Swayam, MOOC, NPTEL *etc.*	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; C-Core papers for B. Sc. Chemistry Major and B-Core papers for B. Sc. Biology/ Biotechnology Students]

[Online Courses have an extra Credit (Other Than 90 credits). Two online courses are mandatory and the students also can do more than two courses based on their ability. All these courses will entered in the consolidated mark statement and will not be included for grading]

BHARATHIAR UNIVERSITY, COIMBATORE 641 046
UNIVERSITY DEPARTMENT
M.Sc., NANOSCIENCE AND TECHNOLOGY (Physics Based)
(For the candidates admitted from the academic year 2018-19 onwards)
SCHEME OF EXAMINATION-(CBCSPATTERN)

Sem	Code	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..	Offered from Other Departments	2	12	38	50	2
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
	2EA	Advanced Materials Science	4	25	75	100	4
	23P	Practical-I	4	25	75	100	4
	2GS..	Offered from other Department	2	12	38	50	2
	Online Course-1	Online Course from Swayam, MOOC, NPTEL *etc.*	2	50	-	50	2
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
	3EA	Nanodevices and Applications	4	25	75	100	4
	33P	Practical – II	4	25	75	100	4
	37V	Mini Project and Study Tour	2	50	-	50	2
	3GS..	Offered from other Departments	2	12	38	50	2
	Online Course-2	Online Course from Swayam, MOOC, NPTEL *etc.*	2	50	-	50	2
IV	43A	IPR and Biosafety (Self Study)	2	12	38	50	2
	47V	Project and Viva-Voce	12	75	225	300	12
		Total	**90**			**2250**	

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UNIVERSITY DEPARTMENT
M.Sc., NANOSCIENCE AND TECHNOLOGY (Chemistry Based)
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SCHEME OF EXAMINATION-(CBCSPATTERN)

Sem	Code	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 – II	4	25	75	100	4
	13G	Physical Chemistry – I	4	25	75	100	4
	1EB	Analytical Chemistry	4	25	75	100	4
	1GS..	Offered from Other Departments	2	12	38	50	2
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-I	4	25	75	100	4
	2GS..	Offered from other Department	2	12	38	50	2
	Online Course-1	Online Course from Swayam, MOOC, NPTEL *etc.*	2	50	-	50	2
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
	3EA	Nanodevices and Applications	4	25	75	100	4
	33P	Practical – II	4	25	75	100	4
	37V	Mini Project and Study Tour	2	50	-	50	2
	3GS..	Offered from other Departments	2	12	38	50	2
	Online Course-2	Online Course from Swayam, MOOC, NPTEL *etc.*	2	50	-	50	2
IV	43A	IPR and Biosafety (Self Study)	2	12	38	50	2
	47V	Project and Viva-Voce	12	75	225	300	12
		Total	**90**			**2250**	

[Online Courses have an extra Credit (Other Than 90 credits). Two online courses are mandatory and the students can do more than two courses too.]

BHARATHIAR UNIVERSITY, COIMBATORE 641 046
UNIVERSITY DEPARTMENT
M.Sc., NANOSCIENCE AND TECHNOLOGY (Biotechnology Based)
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SCHEME OF EXAMINATION-(CBCSPATTERN)

Sem	Code	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..	Offered from Other Departments	2	12	38	50	2
II	23A	Synthesis and Fabrication of Nanomaterials	4	25	75	100	4
	23B	Properties of Nanomaterials	4	25	75	100	4
	23F	Immunology	4	25	75	100	4
	23G	Pharmaceutical Biotechnology	4	25	75	100	4
	2EB	Environmental Biotechnology	4	25	75	100	4
	23P	Practical-I	4	25	75	100	4
	2GS..	Offered from other Department	2	12	38	50	2
	Online Course-1	Online Course from Swayam, MOOC, NPTEL *etc.*	2	50	-	50	2
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
	3EA	Nanodevices and Applications	4	25	75	100	4
	33P	Practical – II	4	25	75	100	4
	37V	Mini Project and Study Tour	2	50	-	50	2
	3GS..	Offered from other Departments	2	12	38	50	2
	Online Course-2	Online Course from Swayam, MOOC, NPTEL *etc.*	2	50	-	50	2
IV	43A	IPR and Biosafety (Self Study)	2	12	38	50	2
	47V	Project and Viva-Voce	12	75	225	300	12
		Total	**90**			**2250**	

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

CourseType: Core **Semester: I** **Credits: 4**

Preamble: This course is the introductory course for the M. Sc. Nanoscience and Technology and is designed to introduce students to the interdisciplinary aspects of nanoscience by integrating important components of the broad research field. This integrated approach will cross the traditional disciplines of physics, chemistry and biotechnology. Fundamental properties of materials at the nanoscale, synthesis of nanoparticles, characterization tools, self-assembly, and nanoscale devices and systems will be covered.

Prerequisite: Basic knowledge in science(physics, chemistry, biology and mathematics)

Course Objectives: Through this course the students will:

- Understand the relationship between the size and properties for various materials.
- Understand unique interactions and effects occurring at the nanoscale.
- Evaluate appropriate applications for nanoscale processes, materials, or systems.
- Understand the most prominent fabrication approaches for nanoscale materials.
- Understand how quantization in nanomaterials impacts electrical, optical, and magnetic properties*etc.*
- Understand the most prominent metrology & characterization approaches for nanoscale materials.
- Understand how nanomaterials are applicable to, and particularly useful for, electronics, energy devices, and medicine/medical devices.
- Develop/refine ability to present details of a chosen nanoscience phenomenon, technique, tool, material, or device/system by writing a clear review and delivering concise presentation to the class.

Course Outcomes: On completion of this course, students will be able to:

CO1: Describe fundamentals of nanoscience and nanotechnology
CO2: Classification of nanostructures and their properties
CO3: Different types of nanomaterials
CO4: Utilization of nanomaterials in diverse applications.
CO5: Applications in different areas.

Unit-I– GenericMethodologies 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-Giantmolecular solids – The free electron model and energybands – Crystallinesolids –Periodicity of crystallattices – Electronic conduction; Effects of the nanometer length scale-Changes to the system total energy-Changes to the system structure–How nanoscale dimensions affect properties.

Unit-II – CarbonNanostructures

Introduction;carbonmolecules–nature of the carbonbond–new carbonstructures;carbonclusters–smallcarbonclusters – discoveryofC_{60}–structureofC_{60}– crystal–alkalidopedC_{60}–superconductivityinC_{60}–largeandsmallerfullerenes–otherbuck balls;carbonnanotubes– fabrication–structure– electrical properties– vibrationalproperties–mechanicalproperties;applicationsofcarbonnanotubes–fieldemissionandshielding–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 characterization 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 wetinterfaces–Interface Modification– organic thin films –Surface effects on phase separation –Nanopatterning surfaces byself-assembly-nanoscale devices exploiting macro molecular interfaces.

Unit-V -Evolving Interfaces ofNano

Nanobiology - Introduction - Bio-inspired nanomaterials- Interaction Between Biomolecules and Nanoparticle Surfaces– Different Types of Inorganic Materials Usedforthe Synthesis of Hybrid Nano-bioAssemblies - Applications of Nanoin 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 SizeEffects– Electrochemical Sensors– Sensors Based on Physical Properties– Nanobiosensors–SmartDust; Nanomedicines– Introduction– Approach to Developing Nanomedicines- Various Kinds of Nanosystemsin Use - Protocols for Nanodrug Administration-Nanotechnology in Diagnostic Applications –Materialsfor Use in Diagnostic and Therapeutic Applications– Future Directions.

References

1. NanoscaleScience and Technology, RobertW. Kelsall,IanW. HamleyandMarkGeoghegan, John Wiley&Sons,Ltd., UK, 2005.
2. Introduction to Nanotechnology, CharlesP. Poole JrandFrankJ.Owens,WileyInterscience, 2003.
3. Bio-Inspired Nanomaterials and Nanotechnology,EditedbyYong Zhou,NovaPublishers.
4. Nano:The Essentials:Understanding Nanoscience and Nanotechnology,T.Pradeep,McGraw-Hill PublishingCompanyLimited,NewDelhi, 2008.

Course Code and Title: 13B – Classical Mechanics

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

Preamble: This course is a broad, theoretical treatment of classical mechanics, useful in its own right for treating complex dynamical problems, but essential in understanding the foundations of quantum mechanics and statistical physics. The main goal of the course is to introduce students to classical mechanics and its applications and to learn the fundamentals. Classical concepts such as momentum, energy, angular momentum are central to physics and essential for formulating quantum mechanics; one must understand these concepts at the classical level to have any hope of understanding their quantum analogues.

Prerequisite: Basic knowledge in Physics, interest and problem solving skills.

Course Objectives

- The understanding of the history and knowledge of physics and the physics principles

that shape our world

- How to develop familiarity with the physical concepts and facility with the mathematical methods of classical mechanics
- Skills in formulating and solving physics problems along with critical thinking skills.
- How to use Newton's laws of motion to solve advanced problems involving the dynamic motion of classical mechanical systems
- How to represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics

Course Outcomes

CO1: Demonstrate an intermediate knowledge of Newton's Laws

CO2: Demonstrate a basic knowledge of equations of motion

CO3: Understanding basic mechanical concepts related to discrete and continuous mechanical systems

CO4: Knowledge of planar and spatial motion of a rigid body

CO5: Understanding the motion of a mechanical system using Lagrange-Hamilton formalism.

CO6: Students acquire knowledge about the concepts and mathematically formulated laws of mechanics, which enables them to understand mechanical phenomena in nature as well as to solve simple problems

CO7: Apply advanced Newtonian methods to complex motion problems

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 generalization 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, PragatiPrakashan, 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(for Chemistry) **Semester: I** **Credits: 4**

Preamble: The aim of this organic chemistry course is to introduce students to many of the key concepts of organic chemistry through a survey of the basic reactions of selected monofunctional aliphatic and aromatic molecules. Particular emphasis is placed on the underlying mechanistic pathways that are involved together with some of their stereochemical consequences. The application of spectroscopic techniques for the determination of molecular structure is also considered. Hence, the course seeks to establish a sound foundation on which further learning in organic chemistry can built. Practical component:
Pre-requisite: Basic knowledge in chemistry in the intermediate level with little knowledge in organic chemistry.

Course Objectives:

- To understand the basic concepts about how the organic reactions are carried out and also to make the students understand the mechanism of different organic reactions.
- To learn Huckel's rule for find out aromatic nature of organic molecules.
- An organic reaction mechanism is detailed study of the actual steps by means of which a mechanism takes place in a chemical reaction.
- To understand carbon-carbon bond formation.
- To be able to get familiarized with almost all the basic organic concepts.

Course Outcomes: At the end of the course the students should be able to:

CO1: Familiar in aromaticity, which helps to predict new structure analysis.
CO2: Students are able to write mechanisms of organic reactions.
CO3: Students will be able to learn the importance substitution, elimination, and elimination reactions and their applications.
CO4: Students will apply the learned fundamental instrumental techniques in the physical characterization of organic molecules.
CO5: Students will be handled easily most of the reagents and solvents
CO6: To apply all concepts for their new molecules design.

Unit–I

Aromaticity**:**Criteria-Huckel'srule–diatropicmolecules-AromaticityofBenzenoidsandheterocyclic compounds - Non-benzenoidaromaticsazulene,ferrocene,tropolone,sydnonesandannulenes(synthesis not required) - Non-aromatic and anti-aromatic systems.
Study of Organic Reaction Mechanism -non-kineticmethods–product analysis intermediate criteria(isolation,trappingand detection)-isotopiclabellingandcrossoverexperiments-stereochemicalevidence– energyprofilediagrams–intermediatevs.transitionstate.Kineticmethods – mechanistic implications of ratelaw – isotopeeffects–kineticandthermodynamiccontrolofreactions–Hammond'spostulate–linear free energy relationship-Hammett and Taftequations

Unit-II

Aromatic Electrophilic Substitution – mechanism, orientation and reactivity of mono and disubstituted benzenes.Specific creactions –Friedel–Craft'salkylation 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^2andSE^imechanisms-Friedel-Craft'sacylationat olefiniccarbon- Stork-enaminereaction- decarboxylation of aliphatic acids.

Unit-III

Aliphatic Nucleophilic Substitution –SN^1, SN^2,ion-pair, SN^imechanisms-neighboring group participation – stereochemistry– Reactivity- effect of substrate structure,nucleophile,leaving group and there action medium- ambientnucleophiles(region selectivity)and ambientsubstrate- hydrolysis of esters.

Aromatic NucleophilicSubstitution– SN^1,SN^2,$S_NAr$andbenzyne mechanisms- structure and reactivity-effect of substrate structure, leaving groups and nucleophile-typicalreactions -Bucherer, Rosenmund, Von-Braun,Ziegler,Chichibabinreactions -Von-Richter, Sommlett–Hauserand Smiles rearrangements.

Unit-IV

Elimination Reactions–E1, E2andE1cBmechanisms-structural and stereo chemical factors governing eliminations, Hofmann and Saytzeffrule – Bredt'srule –eliminationvs.substitution–pyrolyticeliminations–Chugaevreaction–Hofmanndegradation-Copeelimination.
Addition Reactions:Electrophilic, nucleophilicand freeradicaladditiontodoubleandtriplebonds-hydration,hydroxylation(OsO_4,$KMnO_4$,H_2O_2,Woodward&Prevostmethods),Michaeladdition,hydroborationandepoxidation-sharplessasymmetricepoxidation,Skraupsynthesis.

Unit -V

Oxidation–

Jone'sreagent,Pyridiniumchlorochromate(PCC),Pyridiniumdichromate(PDC),Chromylchloride,Dicyclohexylcarbodiamide(DCC),DMSO,DMSO-Ac_2O,DMSO–oxalylchloride (Swernreaction),Oppenauroxidation, Sommeletreaction- oxidativecleavageof 1, 2 – diols(leadtetra acetate and periodicacid), Etardreaction, Dichlorodicyanobenzoquinone(DDQ),SeO_2, ozonolysis, allylicoxidation (SeO_2&NBS)
Reduction–catalytichydrogenation–typicalreactions–catalystsandsolvents,catalyticdehydrogenation.Metalhydridereduction–typicalreactionsandconditionsused–LiAlH4,$NaBH_4$and $NaCNBH_3$ reductions, hydroboration, 9BBN,tri–n-butyltinhydride(TBH),DIBAL–H,Me_3SiCN,tritertiarybutoxyaluminumhydride,stereochemistryofreductionofcyclicketoneswithmetalhydrides.Dissolvingmetalreductions–Birchreduction,Clemmensenreduction, Wolff-Kishner, Meerwein-Pondorff-VerleyandRosenmundreduction,McMurrayscoupling,cannizzaroreaction,acyloincondensation,Wilkinson'scatalyst.

References

1. Advancedorganicchemistry-Reactions,mechanismandstructure.JerryMarch,McGrawHillKogakushaLtd., 1977.
2. MechanismandTheoryinOrganicChemistry,LowryandRichardson,Harper&RowPublishers,NewYork 1981.
3. Reactions mechanisms inorganic chemistry, Mukergeeand S. P. Singh,McMillan 1976.
4. Organic Chemistry,Vol-I, I.L.Finar, Longmans, 1963.
5. AdvancedOrganicChemistry.JagdambaSinghandL.D.S.Yadav,PragatiPrakasan,2011-12.
6. OrganicSynthesis,7th Edition, Jagdamba SinghandL.D.S.Yadav,PragatiPrakasan, 2011.
7. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge UniversityPress, 1971.
8. Principles of Organic Synthesis, Norman, John Wiley&Sons, 1973.
9. Guidebook to Organic Synthesis, R. K. Mackieand D. M. Smith,Longman, 1982.

Course Code and Title: 13H – Biochemistry

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

Preamble: This is a course offered in first semester for the students admitted who in Biotechnology stream. The course has four credits dedicated to provide the students a strong foundation on the principles and concepts of biochemical metabolism.

Prerequisite: Basic understanding of Biochemical concepts

Course Objectives: 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.

Course Outcomes: On the successful completion of the course, students will be able to

CO1: 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
CO2: the student with a firm foundation in the biochemical aspects of cellular functions which forms a base for their future research.
CO3: 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.
CO4: Interpretation of subject knowledge with the bio molecules and the process of energy metabolism
CO5: Understanding the analytical techniques and its basic principles
CO6: Demonstration of how basic biomolecules involved in life process in living cells

Unit-I

Structure of atoms, molecules and chemical lbonds; Classes of organic compounds and functional groups.Covalent and Noncovalent interactions–VanderWaals, Electrostatic,Hydrogen bonding and hydrophobic interactions, Thermodynamics, kinetics, dissociation and association constants: Enzymes and coenzymes; Respiration and photosynthesis. Chemical foundations of Biology-pH, pKa,acids, bases and buffers, Henderson–Hasselbachequation, biological buffer solutions. Energy metabolism (concept of free energy);Principles of thermodynamics; energy rich bonds; weakinteractions;coupledreactionsandoxidativephosphorylation;group transfer; biological energy transducers;bioenergetics.

Unit -II

*Sugars***:**
classificationandreactions.Polysaccharides:classification,occurrence,isolation,purification,propertiesandbiologicalreactions. Structural features of homoglycans, heteroglycans and complex carbohydrates. Methods for compositional analysis.
*Proteins:*Aminoacids and peptides-classification,chemical reactions and physical properties.Peptidebond,Primary structure of proteins,structural comparison at secondary and tertiarylevels (Ramchandranmap),conformation of proteins and polypeptides(secondary,tertiary,quaternaryanddomainstructure),Purificationandcriteriaofhomogeneity: proteinfolding – biophysical and cellular aspects.
Lipids:Classifications,
structureandfunctions.Triglycerides;Phospholipids;Steroidsandterpenes.Glycoand lipoproteins-structure and function.Role of lipids in biomembranes.
Nucleic acids: Structure of double stranded DNA(B, A, C, D, TandZDNA).Thebiologicalsignificanceofdoublestrandedness,sequencedependentvariationintheshape ofDNA.PhysicalpropertiesofdoublestrandedDNA. Types of RNAs and their biological significance. DNAbending, DNA super coiling .Conformational properties of polynucleotides, secondary and tertiary structural features and their analysis.

Unit -III

Enzymekinetics(negative and positive cooperativity);Regulation of enzymaticactivity; Enzymecatalysisin solution. Kinetics and the rmodynamic analysis,effects of organicsolvents on enzymecatalysis and structural consequences.Active sites; Coenzymes: activators and inhibitors, kinetics of enzymeinhibitors, isoenzymes, allosteric enzymes;Ribozyme,hammerhead,hairpin and otherribozymes,strategies for design in gribozymes.Abzyme: structure and drugtargets(enzymes and receptors);Prodrugdelivery using enzymes; Bioluminescence

Unit -IV

Silkfibroin,coiledcoils,collagentriplehelixandhemoglobin.Denaturationandrenaturationof proteins.Lysozyme-structure,enzymicactivity,mechanismoflysozymeaction.Analyticaltechniques:separationtechniques, small and macro biomolecules,Protein-Proteinandprotein-ligandinteractions.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 off attyacids; Triglycerides;Phospholipids;Sterols.

References

1. Biochemistry, ChristopherK. Mathews,KensalE. vanHolde ,KevinG. Ahern, 3rdEdition, Pearson Education, 2000.
2. PrinciplesofBiochemistry,AbrahamWhite,PhilipHandler,EmilL.Smith.,McGraw–HillInternational book Company, 8th Edition, 1973.
3. Principles of Biochemistry,Lehninger,Nelson,Cox,CBS publishers and distributors,NewDelhi, 2004.
4. FundamentalsofBiochemistry,DonaldVoet,AkifUzman,JudithG.Voet,CharlotteW.Pratt, John Wileyand Sons, NewYork, 2008.
5. Biochemistry, GeoffreyL.Zubay, WCBpublishers, 1998.
6. Harper'sBiochemistry, R.K.Murray,D.K.Granner,P.A.MayesandV.WRodwell, 24thedition, Stamford, 1996.
7. Biochemistry (6th Ed.)–J.MBerg;J.L.TymoczkoandL.Stryer,WHFreemanandCompany,NY.

Course Code and Title: 13C – Quantum Mechanics

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

Preamble: This course develops concepts in quantum mechanics such that the behavior of the physical universe can be understood from a fundamental point of view. We will discuss analytic solutions to the Schrodinger equation for a variety of potentials in one, two and three dimensions. The role of symmetries as the underlying principle of Quantum Mechanics will be emphasized throughout the course. The use of symmetry principles and operators methods will be discussed.

Prerequisite: Basic knowledge in General Physics and Mathematics

Course Objectives

- How to perform calculations on simple systems using the Schrödinger equation; we introduce Heisenberg's principle of uncertainty, the concept of spin and the Pauli principle.
- To understand the central concepts and principles in quantum mechanics, such as the Schrödinger equation, the wave function and its statistical interpretation, the uncertainty principle, stationary and non-stationary states and time evolution of solutions

- Be able to solve the Schrödinger equation on their own for simple systems in one to three dimensions, both analytically and by using robust numerical methods.
- Relating the knowledge of mathematics to the formalism of quantum mechanics

Course Outcome

CO1: Pinpoint the basic of quantum mechanics starting from Eigen functions and values
CO2: Understand and explain the differences between classical and quantum mechanics
CO3: Understand the idea of wave function and the uncertainty relation
CO4: Able to solve Schrodinger equation for simple potentials
CO5: Spot, identify and relate the eigenvalue problems for energy, momentum, angular momentum and central potentials explain the idea of spin
CO6: General experience with non-relativistic quantum mechanics that is useful for further studies in theoretical physics, as well as nanotechnology

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- Tunneling 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

13F: Inorganic Chemistry – I

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

Preamble: The aim of this course is to provide a core for future studies in inorganic chemistry and allied subjects, in the following areas; Homocyclic and Heterocyclic Ring Compounds; Reactionsin Non-aqueous Solvents; Nuclear Chemistry; Experimental methods; Nuclear Reactions.

Pr-requisite: Basic knowledge in chemistry in the intermediate level with little knowledge in inorganic chemistry.

Course Objectives:

- To enhance the level of understanding of structure, bonding and reaction mechanism involved in inorganic complexes.
- To learn inorganic homocyclic and heterocyclic ring compounds.
- To enable students to apply the concepts of non-aqueous solvents and acids-bases theory.
- To analyse and interpret nuclear reactions.

Course Outcomes: At the end of the course the students should be able to:

CO1: Students will be able to analyze how structure and bonding, reactivity influence the functions and to design & develop new systems.
CO2: Students will be able to use various inorganic solvents for modern biomaterials synthesis.
CO3: Students will know how to synthesize inorganic materials and analyze them using various analytical instruments.
CO4: Students will be Identified the structure and bonding aspects of simple nuclear reactions.

Unit-I

Homocyclicand HeterocyclicRing Compounds **-** Borazines,phosphonitriliccompounds,sulphur-nitrogencompounds,organohalosilanes,silanols,siloxanes,silylamines(silazenes)Isopolyandheteropolyacids of vanadium, chromium, molybdenum and tungsten

Unit -II

Reactionsin Non-aqueous Solvents: Classification of solvents – properties of ionizing solvents – a general study of the typical reactions inliquid ammonia,Sulphur dioxide,anhydroushydrogenfluoride,hydrogensulphideandhydrogencyanide– acomparativestudy,organophosphoruscompounds,alkyllithiumcompounds.
Acids and Bases-Lowry-Bronsted theory-Lewis concept–Hardness and softness of acids and bases.

Unit-III

NuclearChemistry-Thenucleus–subatomicparticlesandtheirproperties–bindingenergy-n:pratiosinstable and metastablenuclei–Different types of nuclear forces–Liquid dropmodel and Shell model.

Modes of radioactive decay– The oryofalphadecay, beta decayandgamma radiation.Orbital electroncapture, nuclearisomerism–Internal conversion.

Unit-IV

*ExperimentalMethods***–** Cloudchamber, nuclearemulsion,bubblechamber,proportionalcounters, G M counter, Scintillation and Cherenkovcounters

*ParticleAccelerators***-**Linear accelerators –cyclotron,synchrotron,Betatronand Bevatron.

Unit-V

*NuclearReactions***-**Q–value,coulombicbarrier–nuclearcrosssection–differenttypesofnuclearreactions – projectilecapture– particleemission,spallation,fissionandfusion–Productdistributions– theoriesoffission,useoffissionproducts,fissileandfertileisotopes-U-233,U-235,Pu-239, Th-232 – Stellarenergy–Synthesis of new elements.

*RadioIsotopes***–** Applications–isotopesastracers–neutronactivationanalysisandisotopicdilution analysis– uses in structure and mechanistic studies– carbon dating.

References

1. Advanced Inorganic Chemistry,F.A. Cotton andG. Wilkinson, C. A. Murillo, M.Bochmann,John Wiley&Sons, VIEdition, 2003-04.
2. ModernAspectsofInorganicChemistry,H.J.EmeleusandA.G.Sharpe,JohnWiley&Sons, 1973.
3. Source book on Atomic Energy,S. Glasstone,Krieger Pub. Co., 1979.
4. AdvancedInorganicChemistry,GurdeepRajandMehraHarish,GoelPublishingHouse,1976.
5. Chemistryin Non-aqueous solvents, HarryH.Sisler, Reinhold, 1961
6. Nuclear and Radiochemistry,G.Friedlander,J.W.Kennedy andJ.M.Miller,JohnWiley,1964.
7. InorganicChemistry,J.E.Huheey,E.A.Keiter,R.L.Keiter,O.K.Medhi,PearsonEducationInc., 1993.

Course Code and Title: 13I – Microbiology

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

Preamble: The course offered in the first semester to make students to deal with the microscopic living structures. Understanding the elemental knowledge of microorganisms and its life process is the prime focus.

Prerequisite: Acquire knowledge on basics of microorganisms

Course Objectives:

- To acquaint students with the basic laboratory techniques and tools of microbiology.
- To introduce the fundamental characteristics of various microorganisms.
- To develop lab skills, including collection and analysis of data, the ability to draw valid conclusions and apply these conclusions within a larger framework.
- To develop a heightened sense of understanding in students about the microscopic world around them.

Course Outcomes: On the successful completion of the course, students will be able to

CO1: the students will get an overall understanding of basic history and classification of microorganisms

CO2: learning the techniques to obtain auxienic culture and cultivation of microorganisms using range of media

CO3: to get equipped with the theoretical understanding of growth parameters and study the kinetics of growth

CO4: to provide information on various types of sterilization techniques and standard procedures involved to achieve contamination free environment.

CO5: Understanding the growth physiology of microorganisms and its metabolic process

CO6: to provide basic information on conversion and synthesis of macromolecules and their role in metabolism

Unit-I

History of Microbiology - HistoryofMicrobiology.Principlesofclassificationofmicrobes;morphological,metabolicandmolecular criteriafortheclassification,abriefintroductiontomajor group of bacteria.Ultrastructureofbacteria.

Unit -II

MicrobialCultivation-
Nutritionaltypesrequirementsofbacteria.Cultivationofbacteria:Pureculturetechniquesdifferentmedia .Culturemediaandpreparation:
Preservationofculturesaerobicandanaerobicculturetechniques.Batchandsynchronouscultures.Growthcurve 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

Microbialphysiology-Staining characteristics,Gramstaining,AFB staining,florescentstaining,serologicalcharacteristics:-
surfaceantigen,capsularantigen&flagellarantigen,
Culturalcharacteristics,Photosyntheticmicroorganisms,cyclicandnon-cyclicphotophosphorylation,electrontransportchaininphotosyntheticbacteria.Bacterialaerobicrespiration,Bacterialanaerobicrespiration:introduction.Nitrate,carbonateandsulfateaselectronacceptors.Electrontransportchainsinaerobicbacteria.Mechanismofoxygentoxicity.Bacterialtransportsystem-ABC,Secpathway,PTS,roleofpermeasesintransport,differentpermeases in E. coli.

Unit V

Microbial Diversity – Generalpropertiesoffungi,fungalclassification,economicimportanceof fungi,Mycoplasma,Actinomycetes, Archebacteria(extremophiles) and microbialalgae.

References

1. Microbial Physiology and MetabolismbyCaldwell D.R. 1995BrownPublishers.
2. Microbial Physiology by Moat A.G.andFoster J. W. 1999. Wiley.
3. Prokaryotic Development byBrun.Y.V.andShimketsL.J. 2000. ASM Press.
4. Advances in Microbial Physiology.Volumes.EditedbyByA.H.Rose.AcademicPress,NewYork.
5. Applied Microbial PhysiologybyRhodes.
6. Principles of bacteriology,virologyand immunologyVolITopleyand Wilson Zinser, Microbiology
7. Microbiology, Prescottt, Harleyandklien
8. Foundations in MicrobiologyTalaroandTalaro
9. Text book of Microbiology, R AnanthanarayananC K JPanicker
10. Microbiology,Pelczar, ChanandKreig.

Course Code and Title: 13D – Mathematical Physics

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

Preamble: The intent of the course has been to cover a number of intermediate and advanced topics in applied mathematics that are needed by science and engineering majors. The course was originally designed for postgraduate level students enrolled in Physics, Applied Physics, Nanoscience and Technology and other engineering departments. This emphasizes the development of rigorouslogical thinking for solving different kinds of problemsthatoccur in mathematical applications. The material we cover includes intermediate topics in Matrices, Linear algebra, Special differential equations, Fourier series, Fourier and Laplace transforms, theorem and Applications of these transformations. We have used an organization that can develop fundamental pedagogical knowledge for solving real, physical problems.

Prerequisite: Under Graduate level, differential and integration Calculus – Use theorems and Logics

Course Objectives: The objective of this course is to develop a working knowledge of Mathematical Physics at the post-graduate level and to use this knowledge to explore various applications.

Course Outcomes: On the successful completion of the course, students will be able to

CO1: Learn the types and properties of Matrices and find the rank of matrices.

CO2: Solve linear homogeneous and non-homogeneous equations and Use Cramer's rule and Check the Eigen values and vectors of matrices.

CO3: Find the solutions of linear and non-linear second order differential equations and apply power series and extended power series methods for identical equations.

CO4: Understand and validate the properties and generating functions of Legendre, Bessel and Hermite's polynomial functions

CO5: Represent first and second translational properties Laplace transforms, derivatives and theorems.

CO6: Verify Laplace and Inverse Laplace transformation of given functions

CO7: Identify and use the Fourier series expansions and theorems and Solve problems relevant to periodic functions.

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 – Cramer's 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, PragatiPrakasam, 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.

CourseCode and Title:13G–PhysicalChemistry-I

CourseType:Core(for Chemistry) **Semester:I** **Credits: 4**

Preamble: Physical chemistry is the study of macroscopic, atomic, subatomic, and particulate phenomena in chemical systems in terms of the principles, practices, and concepts of physics such as motion, energy, force, time, quantum chemistry, analytical dynamics and equilibrium. The students pursuing this course would have to develop in depth understanding of various aspects of the subject. Physical chemistry courses are instilled in with the knowledge of chemistry and the fundamentals used for its applicability in the career. Students are imparted with the analytical, evaluative and interpreting skills so as to help in solving problems.

Prerequisite: Higher Secondary Level, Degree Level – Molecular symmetry, kinetic theory, Classical mechanics, electrochemistry.

Course Objectives

- To understand the basics of molecular symmetry, point symmetry, rate of the reaction and type of the chemical reaction.
- To understand the basics of various catalytic reactions.

Course Outcomes: After learning this course the students can able

CO1: To understand the fundamental concepts and techniques used in group theory.
CO2: To understand molecular symmetry and its application in character table
CO3: To explain the Raman and IR active compounds
CO4: To understand and analyze the various chemical kinetics
CO5: To explain rate of the reaction.
CO6: To solve kinetics and equilibrium problems
CO7: To understand enzyme catalysis to find the mechanism of reaction.

Unit-I

Molecularsymmetryandgrouptheory–Pointsymmetry–SchonfloesandHerman –Mauguinnotations–identificationofpointgroupsofsimplemolecules–postulates of grouptheory–group multiplication table – orthogonality and irreducible representations–applicationoftheorthogonalitytheoremtoobtaintheirirreduciblerepresentationsofthepointgroupsC_{2v}andC3vonly–character table(explanation) different areas of the character tables.

Unit-II

ApplicationofthegrouptheoreticalmethodstofindthetotalnumberofvibrationsofsimplemoleculessuchasH_2OandNH_3–SelectionruleswithregardtoRamanandIRactivitiesandelectronictransitions–splittingoforbitalsinOh,Td and D4hsymmetries–hybridizationasappliedtomethaneandwater–simplificationofMOcalculationsemployingsymmetryadoptedlinearcombinationmolecularorbital procedure – application to butadiene.

Unit-III

Chemical Kinetics -The ARRT – thermo dynamic treatment of ARRT– significance ofreactioncoordinate –application of ARRT – Unimolecular and bimolecularprocesses–potential energysurface– Kinetic isotopic effect– Principles of microscopic reversibility–Steady State Approximation– third order and intermolecular reactions– Applications of ARRT to solution kinetics – Factors affecting reactionrates in solution.
Chainreactionsandexplosions–Homogeneouscatalysis,Acid–basecatalysis–salteffects – Acidityfunctions– Zucker-Hammethypothesis– Bunnett criterion.

Unit-IV

Enzymecatalysis–Mechanismofsinglesubstratereaction–influenceofpHandtemperature–fastreactions–Kineticsofpolymerizationinsolution–
Heterogeneouscatalysisadsorptionandfreeenergyrelationatinterfaces–Gibbsadsorptionisotherm–Physicaladsorption–Chemisorption–PotentialenergydiagramandLennard – Jonesplots–LangmuirandBETisotherms–Measurementofsurfacearea–Semiconductorcatalysis–Langmuir–HinshelwoodandLangmuir– Rideal– Eleymechanisms

Unit-V

Fast Reactions- Study bystop-flow techniques, relaxationmethods. Flashphotolysis,magnetic resonance methods. Kinetic the oryofgases. Postulates–Maxwell distribution of Molecular velocities-Expressionsformostprobablevelocity,averagevelocity,root means quarevelocity. Collision diameter,Collision frequency, Mean free path.Transportpropertiesofgases–Thermalconductivity,Viscosity,Diffusion – principle of equipartitionof energy.

References

1. F. A. Cotton, Chemical Applications of GroupTheory
2. Ramakrishnan and Gobinathan, Group Theoryin Chemistry
3. Raman, Group Theory

4. K.J. Laidler,Chemical Kinetics,TataMcGrawHill
5. Gurdeep Raj, Chemical Kinetics, GoelPublishingHouse.
6. P.W.Atkins,Physical Chemistry
7. W.J.Moore,Physical Chemistry,Longmans
8. A.A.FrostandR.G.Pearson, Kineticsand Mechanism, WileyEastern, Pvt.Ltd.

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

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

Preamble: A Nanoscience and Technology (with biotechnological) student needs to have some basic definition of cell, concepts of cell theory, structure and organization of membranes, molecular events of electron transport chain, structure and types of DNA & RNA, basic mechanisms of gene regulation, different stages of cell cycle (M Phase and Interphase), cell division (Mitosis and Meiosis) and cell differentiation (Gametogenesis and Fertilization). The main objective of this course is to introduce the basic mechanisms of cell cycle and gene regulation used in biotechnological applications. Based on this course aims to giving adequate exposure in the concepts of cell theory, structure and functions of cytosol, mitochondria, chloroplast, endoplasmic reticulum, mechanisms of DNA Replication, transcription, translation and cell differentiation of gametogenesis and fertilization.

Prerequisite: Higher Secondary Level, Degree Level – Cell theory, cell division and cell cycle.

Course Objectives:

- To gain a thorough understanding of the basic concepts of cell and molecular biology relevant to nanoscience and nanotechnology.
- To understand the (i) organization of biological systems such as viruses, prokaryotic and eukaryotic cells.
- To understand the structures and types of nucleic acids (DNA & RNA) and basic mechanisms of cell division.

Course Outcomes: On the successful completion of the course, students will be able to,

CO1: The structure and function of the eukaryotic cell and its organelles.
CO2: The genetic information flow in the eukaryotic cell; including nucleic acid structures, the definition of a gene, the organization of the genome, the replication, the formation of RNA (transcription), the processing of pre mRNA and the protein synthesis (translation).
CO3: The cell cycle and the cell division and account for how these are regulated.
CO4: How cells can communicate and the central intracellular signal transduction pathways.
CO5: Cell motility and regulation of cell form and movement; including cytoskeleton organization and generation of force and cell motility.
CO6: Understand and apply the principles and techniques of molecular biology which prepares students for further education and/or employment in teaching, basic research, or the health professions.
CO7: Various levels of gene regulation and protein function including signal transduction and cell cycle control.
CO8: Related properties of cancerous cells to mutational changes in gene function.

Unit-I

Definition of cell: Structure and function of cells in prokaryotes and eukaryotes; Structure and organization of Membrane - Model membranes, Glyco conjugates and proteins in membrane

systems. Intra cellular matrix: structure and biogenesis - Cytosol, mitochondria, chloroplast, endoplasmic reticulum, peroxisome, lysosomes, endosomes, cytoskeleton .Extra cellular matrix – cell to cell and cell matrix adhesion – selectins, Integrins, cadherins, gap junctions.

Unit-II

Molecular events of electron transport chain: Hydrogen and electron carriers, ATP synthase, Oxidative phosphorylation, photosynthesis and photorespiration. Protein synthesis and post translational modification of proteins vesicular transport and import into cell organelles. Response to stress – active transport, passive - mediated transport, thermodynamics of transport, transport channels and pumps, Neurotransmission, neuromuscular junction.

Unit -III

Oxidative reactions in microbodies: Peroxisomes and Glyoxysomes. Nucleus, The nucleosome, the supranucleosomal structures; Nucleic acid structure and types: DNA (Double helix structure) 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

Cell cycle: Different stages of cell cycle - M Phase and Interphase, factors and genes regulating cell cycle. Mechanism of cell division: Mitosis: Prophase, Metaphase Anaphase and Telophase. Meiosis: Different phases of meiosis. Significance of meiosis, post reductional meiosis &chiasmaterminalization.Comparison of Mitosis and Meiosis. Cell signaling – types of cell signaling - G protein mediated, Tyrosine kinase mediated signaling.

Unit-V

Cell differentiation; gametogenesis and fertilization; life cycle and molecular biology of some pathogens – AIDS virus, tuberculosis, malaria parasite, hepatitis virus, filarial parasite and kalazar parasite.Biochemistry and molecular biology of Cancer, tumour suppressor and oncogenes.

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**

Preamble: This course deals with semiconductor device characteristics, Op-Amp characteristics and their applications and digital principles

Pre-requisite: Basic knowledge in physics or applied science.

Course Objectives

- To understand the basics of number systems, digital logic levels, functionality of digital components and
- Operation of digital electronics circuits.
- To construct and analyse various digital electronic circuits

Course Outcomes: After learning this course the students can able to understand

CO1:the fundamental concepts and techniques used in digital electronics.
CO2:binary number systems and its application in digital electronics
CO3: the functionality of logic gates
CO4: and analyze the various digital logic functions
CO5: the design Karnaugh map to simplify the Boolean functions
CO6: and design various combinational circuits to solve problems
CO7:the design of various timer and sequential circuits
CO8: and analyze the interface between digital and analogue electronics
CO9: the basic concepts of molecular device structure and analyse their operation

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**

Preamble: This course content covers all aspects of analytical chemistry such as from classical analytical techniques tools modern sophisticated instrumentation, the Instrumental methods of chemical analysis have become backbone of experimental Chemistry. Method development for new product is one of the essential requirements for the expansion of research in the new product development. This elective course will very well cater the post graduate students to design new analytics and methodology development.

Pre-requisite: The master students of the Nanoscience and technology who has completed their under graduation in any branch of chemical-physical sciences or biotechnology can opt this course as elective.

Course Objectives: Students will develop the skill necessary to solve analytical problems in a quantitative manner, particularly with the aid of the spreadsheet tools that are so commonly available. Finally, we aim to teach those laboratory skills that will give students confidence in their ability to obtain high-quality analytical data.

Course Outcomes: Upon successful completion of this course, the student will be able to:

- **CO1:** Demonstrate a mastery of various methods of expressing concentration.
- **CO2:** Use a linear calibration curve to calculate concentration.
- **CO3:** Describe the various spectrochemical techniques as described within the course.
- **CO4:** Use sample data obtained from spectrochemical techniques to calculate unknown concentrations or obtain structural information where applicable.
- **CO5:** Describe the various chromatographies described within this course and analyze a given chromatogram.
- **CO6:** Demonstrate an understanding of electrochemistry and the methods used to study the response of an electrolyte through current of potential.

Unit-I

Fundamentals of Analytical chemistry: Applications of quantitative analysis-performance of quantitative analysis - choice of methods for an analysis - errors in chemical analysis - sampling, standardization and calibration.

Unit-II

Separation Techniques: Solvent extraction - introduction to chromatography - types of chromatography - efficiency of separation - factors affecting resolution.

Unit-III

Electro analytical techniques: Introduction to electrochemistry-applications of standard electrode potentials- applications of oxidation/reduction titrations- potentiometry -electrogravimetry - coulometry - voltammetry.

Unit-IV

Modern analytical techniques:UV-visible absorbtion spectroscopy - principles and instrumentation - Raman spectroscopy - Raman spectrum- theory- instrumentation- structural characteristics - quantitative analysis - Infra-red Spectroscopy - basic principle-instrumentation – correlation of infrared spectra with molecular structure - Nuclear magnetic resonance spectroscopy - Basic principles of NMR - Instrumentation.

Unit-V

Green Chemistry Principles- Definition, need of green chemistry, twelve basic principles ofgreen 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. Fundamentals of analytical chemistry, Douglas A. Skoog, Donald M. West.
2. Fundamentals of analytical chemistry, Skoog, West, Holler, Crouch.
3. Instrumental methods of analysis, Hobart H. Willard, Lynne L. Merritt, JR., John A. Dean.
4. Quantitative chemical analysis, Daniel C. Harrish.
5. Green Chemistry, V.K.Ahluwalia.
6. Green Chemistry, P.T. Anastas and J. C. Warner, 1998
7. Green Chemistry, S. Delvin.

Course Code and Title: 1EC – Biostatistics

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

Preamble: This paper highlights on vital statistical techniques for analysis of biological data.

Pre-requisite: Little knowledge on intermediate level.

Course 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.

Course Outcomes: On successful completion of this course, students will be able to:
CO1: Apply basic statistical concepts commonly used in Health and Medical Sciences;
CO2: Use basic analytical techniques to generate results;
CO3: Interpret results of commonly used statistical analyses in written summaries; and
CO4: Demonstrate statistical reasoning skills correctly and contextually.

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, Variation, SD, cv); Probability (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; Profit analysis; Multivariate 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 EductionInc, 1999.
2. Biostatistics – How it works, Steve Selvin, Pearson Eduction Inc.
3. An introduction to Biostatistics, Glover and Mitchell, McGraw 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 FabricationofNanomaterials

CourseType: Core **Semester:II** **Credits: 4**

Preamble: This course helps the students to understand the different typesnanomaterials synthesis by both top-down and bottom up approach using various physical chemical and biological approaches.

Prerequisite: Basic knowledge in science(physics, chemistry and biology)

Course Objectives: Through this course the students will:

- To learn about bulk synthesis of nanomaterials.
- To know about physical, chemical and biological approaches of nanomaterials synthesis.
- To learn about nanoporousand composite materials and application of nanomaterials.
- To understand the lithographic process for the fabrication nanodevices.

Course Outcomes: On completion of this course, students will be able to:

CO1: synthesizenanomaterials using various physical, chemical and biological approaches.
CO2: tune the size and shape of the nanomaterials for diverse applications.
CO3: understand the functionalization of nanoparticles
CO4: form the nanocomposites for tuning their functional properties.
CO5: fabricate the device structures using lithographic techniques.

Unit-I - Chemical Methods

Sol-GelProcess– Self-assembly – Electrodeposition – SprayPyrolysis– FlamePyrolysis– MetalNanocrystals by Reduction– Solvothermal Synthesis– Photochemical Synthesis– Sonochemical Routes–ReverseMicelles and Microemulsions– Combustion Method– TemplateProcess– Chemical Vapor Deposition(CVD)–Metal Organic ChemicalVapor Deposition(MOCVD)

Unit-II - Physical Methods

BallMilling – InertGasCondensationTechnique(IGCT)–Thermalevaporation– PulsedLaserDeposition(PLD)–DC/RFMagnetronSputtering – MolecularBeamEpitaxy (MBE)– Melt Spinning process- ICFabricationProcess– Microlithography– Etching – WetCleaning– CMP–

BackendProcess.

Unit-III -Biological Synthesis

Introduction-Natural NanocompositeMaterials – 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 ThinFilms - Block-Copolymer Templating-Colloidal Templating.

Unit-IV Nanocomposites

Ceramic/Metal Nanocomposites-Metal Matrix Nanocomposites– Nanocomposites for HardCoatings– Polymerbased nanocomposites– nanoscalefillers– processing of polymernano composites – Properties of polymer nanocomposites. Core – Shell structurednano composites– morphologyandfractalmodelofhybridnanocomposites– intercalationprocess–polymerizationintothebasalspace– macromoleculesintroductionintothelayeredhost

Lattices - Langmuir – Blodgettmetallopolymers films as self-organized hybridnanocomposites.

Unit -V –LithographicMethods

Introduction–Lithography–Photolithography– Phase – shifting photolithography – Electron beamlithography-X-raylithography – Focuse dionbeam(FIB)lithography – Neutral atomicbeamlithography – Nanomanipulation and Nanolithography– SoftLithography– Assembly of Nanoparticles and Nanowires Other Methods for Microfabrication.

References

1. Recent AdvancesintheLiquid-phase synthesis ofinorganicnanoparticles,BrainL.Cushing,VladimirL.Kolesnichenko,CharlesJ.O'Connor,ChemRev.104 (2004)3893-3946.
2. Nanocrystals:Synthesis,PropertiesandApplications,C.N.R.Rao,P.J.ThomasandG. U. Kulkarni, Springer(2007).
3. Nanotechnology – Enabled Sensors,KouroshKalantar – zadeh and BenjaminFry,Springer(2008).
4. Nanostructures& Nanomaterials: Synthesis, Properties&Applications,GuozhongGao, ImperialCollege Press (2004).
5. Nanochemistry:AChemicalApproachtoNanomaterials– RoyalSocietyofChemistry,Cambridge,UK (2005).
6. Nanocompositescienceandtechnology,PulickelM.Ajayan,LindaS.Schadler,PaulV.Braun,Wiley-VCHVerlag,Weiheim (2003).
7. EncyclopediaofMaterialsCharacterization,C.RichardBrundle,CharlesA.EvansJr.,Shaun Wilson, Butterworth-Heinemann Publishers (1992).
8. HandbookofMicroscopyforNanotechnology,Ed.ByNanYaoandZhongLinWang,KluwerAcademic Press (2005).
9. Nanochemistry, G.B.Sergeev, Elsevier (2006).
10. Nanotechnology:BasicScienceandEmergingTechnologies– MickWilson,KamaliKannangara,Geoff Smith, Michelle Simmons, BurkhardRaguse,OverseasPress(2005).
11. HandbookofAnalyticalTechniques,EditedByHelmutGünzlerandAlexWilliams,WileyVCH, 2002.

Course Code and Title: 23B – Properties of Nanomaterials

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

Preamble: The Properties of Nanomaterials course will give an information about the properties of materials at the nanoscale and also a comparison with its bulk counter parts.

Pre-requisite: This core course is designed for the masters in Nanoscience and technology those who have acquired basic degree with a knowledge of material science.

Course Objectives: This course will provide students to gain a thorough understanding of the structure-property relationships at nanoscale as well as the concepts on various properties and critical evaluation of the promising nanotechnology devices.

Course Outcomes:

- **CO1:** The student will demonstrate a basic understanding of the length scale that defines nano for metal and semiconductor materials.
- **CO2:** The student will demonstrate an understanding of the properties of materials with strong dependence on size.
- **CO3:** The student will demonstrate an understanding of approaches to nanomaterials characterization.
- **CO4:** The student will demonstrate an understanding of approaches to engineering nanomaterials and nanostructures.
- **CO5:** The student will demonstrate an understanding of the challenges on safe nanotechnology.

Unit I - Electrical and Mechanical Properties

Introduction - Energy Storage Basics - General Information: Electrical Energy Storage Devices and Impact of Nanomaterials – Batteries – Capacitors - Electrochemical Properties of Nanoscale Materials - Aerogels and Structure-Directed Mesoporous and Macroporous Solids - Nanoparticles - Nanotubes, Nanowires, and Nanorolls.

Nanoscale Mechanics - Introduction – Mechanical properties – 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 to catalysis and Nanocatalysis-Catalysts- Types of catalyst- Applications of catalysis – Metal-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 – nanocrystalsuperlattices.

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 - Issue in nanoscale magnetism.

Unit V-Nanoelectronics

Introduction to electronics - 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.
6. Principles of Physical Chemistry- Samuel H. Maron, Carl F. Prutton.

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

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

Preamble: The objective of this course is to register the concepts of equilibrium statistical mechanics which evolved out of the desire to explain thermodynamics from fundamental laws of physics governing the behaviour of atoms and molecules. Being a science built on a set of macroscopic observations, thermodynamics offers inefficient ways of incorporating molecular level information. Thus, an approach based solely on thermodynamics is not sufficient if we hope to achieve desired materials properties through manipulation of nanoscale features and/or molecular level architecture of materials. The course is designed for postgraduate level students enrolled in Physics, Applied Physics, Nanoscience and Technology and other engineering departments. Thisemphasizesthedevelopmentofthoroughconsistentthinkingforsolvingdifferentkindsofproblemstha toccur in macroscopic and microscopic systems. The syllabus includes intermediate topics in Microcanonical, Canonical and Grand canonical Ensembles, Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann Distributions, Heat Capacities, Phase Transitions, Thermodynamics, Microstates and Macro states. We have well pledged team of dedicated staffs who can essentially amplify the academic acquaintance for the enrolled students.

Pre-requisite: Under Graduate level knowledge in basic physics, differentiation and integration to solve problems.

Course Objectives: The main goal of this course is to acquire fundamental knowledge of classical and quantum statistical mechanics; construct a bridge between macroscopic thermodynamics and microscopic statistical mechanics by using mathematical methods and fundamental physics for individual particles. Problem solving is stressed as a means of imparting physical understanding and intuition. We will study how general principles of statistical mechanics actually work in some simple and complex systems and what powerful notions and ideas have been developed to approach complex cases. We will explore relationships between macroscopic properties of large systems and microscopic behavior of the particles these systems are comprised of. The richness and complexity of the behavior exhibited by many-particle systems is incredible. In this course, however, we would be able to explore only very few illustrating examples. We will be dealing with elements of statistical

thermodynamics, kinetics, and the theory of phase transitions.

Course Outcome: On the successful completion of the course, students will be able to

CO1: Gain knowledge of the different canonical systems in two energy systems and their partition functions.

CO2: Derive the three different distributions on Bose-Einstein, Fermi –Dirac and Maxwell-Boltzmann equations.

CO3: Evaluated the spectral density of electromagnetic radiation emitted by a black body in thermal equilibrium at a given temperature T.

CO4: Learn the Thermodynamic relations for non-interacting Fermi gas for the Microscopic and Macroscopic system.

CO5: Using the thermodynamics properties of Heat capacities of heteronuclear diatomic gas, Heat capacities of solid.

CO6: Explain the law of Dulong and Petit states that the product of the specific heat capacity of a solid element and its mass per mole is constant. The value of the constant may be found from the principle of equipartition of energy.

CO7: Describes the relationship between changes in chemical potential for components in a thermodynamic system.

CO8: Learn the Gibbs−Duhem equation cannot be used for small thermodynamic systems due to the influence of surface effects and other microscopic phenomena.

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 capacities of metals – Heat capacity 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, AvijitLahiri, University Press, Hyderabad, 2002.

23E: Organic Chemistry – II

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

Preample: This course presents the comprehensive chemistry of natural products, terpenoids, proteins and stereochemistry

Pre-requisite: Basic knowledge in organic chemistry.

Course Objectives:

- To understand the basic concepts about the organic photochemistry reactions.
- To make the students understand the mechanism of different types of intermediate states.
- To learn the Woodward – Hoffmann rules for addition and reagents.
- Learn to apply concerted and stepwise reactions in organic synthesis.
- To learn carbonyl compounds towards organic synthesis.
- To understand the mechanism of stereochemistry reactions.

Course Outcomes: At the end of the course the students should be able to:

CO1: Learners familiar in synthesize of organic compounds based on photochemistry.
CO2: Students will be able to interpret the formation of products using orbital diagram in pericyclic reaction, photochemical reaction.
CO3: Students will be able to explain the chemistry of free radicals.
CO4: Students gain the knowledge on stereochemistry of organic compounds.
CO5: To apply isolation of isomeric compounds.

Unit-I

Organic Photochemistry- Theory of light absorption–electronic excitation - properties &energies of excited states – Jablonski diagram – photo physical processes - fluorescence and phosphorescence - 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*-transisomerisation - 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 andnitrogen 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).

References

1. S. Sankararaman, Pericyclic reactions-A Textbook: Reactions Applications and Theory. Wiley-VCH, 2015.
2. S. Kalaivanai, Organic Photochemistry and Peri Cyclic Reactions, MJP Publishers, 2011.
3. J. March and M. B. Smith, March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, 6th Edition, Wiley, 2007.
4. F. A. Carey and R. J. Sundberg, Advanced Organic Chemistry Part B: Reaction and Synthesis, Springer, 5th Edition, 2010.
5. Advanced Organic Chemistry. Jagdamba Singh and L.D.S.Yadav, PragatiPrakasan, 2011.
6. E. Eliel and A. H. Wilen, Stereochemistry of Organic Compounds 1st Edition, Wiley, 2010.

Course Code and Title: 23G – Immunology

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

Preamble: The course offered to make students to understand the Immunity concepts and its importance in infection free life. Acquire knowledge on Immunity and its life process is the prime focus.

Prerequisite: Get equipped with theoretical knowledge of Immune process

Course Objectives:

- The students will be able to identify the cellular and molecular basis of immune responsiveness.
- The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease.
- The students will be able to describe immunological response and how it is triggered and regulated.
- The students will be able to demonstrate a capacity for problem-solving about immune responsiveness.
- The students will be able to transfer knowledge of immunology into clinical decision-making through case studies presented in class.

Course Outcomes: On the successful completion of the course, students will be able to

CO1: the students will get an overall understanding of basic history and evolution of immunology

CO2: to impart knowledge on infection and involvement of immune response by involving range of immune cells and organs

CO3: to get equipped with the theoretical understanding of antigen and antibody interactions and its structures

CO4: to provide information on various types of vaccines and its immunization schedule

CO5: Understanding the transplantation immunology by studying graft acceptance and rejection mechanisms

CO6: to provide basic information on blood grouping techniques and its role in hypersensitivity reactions

CO7: Help the students to learn techniques involved in immunological concepts and its role in diagnostic immunology

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, and 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 and 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 Manselhaeny
4. Introduction to immunology John w Kimball
5. Textbook of microbiology, Ananthanarayanan and Jayarampaicker.
6. Essential immunology Roitt
7. Basic and clinical immunology stiles, Stobo,Fuden berg wells (eds)

Microbiology and immunology David J Hantges

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

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

Preamble: The objective of introducing this paper is to provide an in-depth knowledge of nuclear structure, nuclear models, nuclear reactions and different elementary particles.

Pre-requisite: Basics knowledge in physics or applied physics

Course Objectives

- To provide the student to understand, analyse the fundamental principles, concepts pertaining to nuclear and particle physics and to apply for real life problems

Course outcomes: After learning this course, the student able

CO1: To understand the basic principles, laws, concepts in nuclear and particle physics
CO2: To understand and analyse the ground breaking experiments related to nuclear decay and apply for nuclear fission and fusion
CO3: To understand various particle interactions and analyse the properties of the particles
CO4: To understand the principles of elementary particles and their interactions
CO5: To explain the methods used to understand the properties of sub atomic particles through scattering experiments
CO6: To apply quantum mechanical concepts to understand nuclear decay
CO7: To apply conservation laws to predict type of interaction

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 ofnuclear 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 - Semiconductor 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.

CourseCode andTitle :23F–PhysicalChemistry-II

CourseType :Core(forChemistry) **Semester :II** **Credits: 4**

Preamble: Physical chemistry blends the principles of physics and chemistry to study the physical characteristics, or properties, of molecules. By understanding these properties, you learn more about the way in which molecules are put together, as well as how the actual structure of a chemical is impacted by these properties. The students studying this subject would have to develop depth knowledge in quantum mechanics and electrochemistry.

Prerequisite:

Higher Secondary Level, Degree Level –Classical mechanics, electrochemistry, Mathematical knowledge.

Course Objectives

- To understand the basics of quantum mechanics, particle and wave nature of the maters.
- To understand the basics of electrochemical reactions.

Course Outcomes: After learning this course the students can able

CO1: To understand the fundamental concepts and techniques used in quantum mechanics.
CO2: To understand Schrodinger equations and its application in diatomic molecule
CO3: To explain the perturbation theory in anharmmonic oscillator and He atom
CO4: To understand the conductivity of electrolyte and its application in electrochemical reaction.
CO5: To understand the concept of electrochemical reaction.

Unit-I

Quantumchemistry:Failureofclassicalmechanicsandthesuccessofquantumtheoryinexplainingblackbod

yradiation – heat capacities of solids – photoelectric effect and the H-atomspectrum-DeBroglie's matterwaves-Heisenberg's uncertainty principle – Schrodingerequation– Born'sinterpretation of the wave function– requirements of the acceptable wavefunction.Algebra of operators- sums and products of operators– commutator –linearoperators-eigenfunctions and eigenvalues – correspondence between physical quantities in classicalmechanics and operatorsin quantum mechanics–Hamiltonian operator– quantization of angularmomentum and its spatialorientation– average(expectation)values– postulates of quantummechanics.

Unit-II

Particle in a onedimensionalbox – quantization of energy – normalization of wavefunction– orthogonality of the particleinaone – dimensionalboxwavefunctions-averagepositionandaveragemomentumofaparticleinaone – dimensional box – illustrationoftheuncertaintyprincipleandcorrespondenceprinciplewithreferencetotheparticleinaone – dimensionalbox – particleinathree – dimensionalbox– separationofvariables– degeneracySolving of Schrodingerequationfor the one dimensional harmonicoscillator - harmonic oscillator. Modelofadiatomicmolecule– illustrationoftheuncertaintyprincipleandcorrespondenceprinciplewithreference toharmonicoscillator.

Unit-III

Solving of Schrodingerequation for arigidrotor – rigidrotormodelofadiatomicmolecule.SchrodingerequationfortheH-atom(orH-likespecies) – separation of variables– energylevels– radialfactors of the H-atomwave functions. Electronspin and the Pauliprinciples-antisymmetricnature of the wavefunctions- Slaterdeterminants- approximate wavefunction of many electron atoms.Needfor approximation methods – theperturbationtheory(firstorderonly)applicationoftheperturbationmethodofsystemssuchastheanharmonicoscillatorandHe-atom–thevariationmethod – applications of variation method to systems such as anharmonic oscillator andHe-atom.

Unit-IV

Calculationofheatofsolvation,hydrationofionicspecies–Ionicstrength–concentrationandactivity coefficient – Debye-Huckellimiting law- ElectrochemicalMethod of determiningactivity coefficients of electrolyticsolutions – Electrolyticconductances–Debye-Huckel – Onsagerequation– verification–WieneffectandDebye – Falkenhagen effect – Thermodynamics of electrochemical reactions –Freeenergyandemf–Standardandformalelectrodepotentials– Problemsbasedonelectrodepotentialsandtheirmeasurements – Ionselectiveelectrodes.

Unit-V

Electrode–Electrolyticinterface–electricaldoublelayer–electrocapillarythermodynamics Lippmanequation–Measurementsofdoublelayercapacitances–Theoreticalmodelsofdoublelayers– HelmholtzandGuoy – Chapmanmodels–Potential of zerocharge–Sternmodel– outer and inner Helmholtzplanes– Specific adsorption of cations,anionsandneutralmolecules – abrief outline of electrokinetic phenomenon and memberanepotentials.

References

1. I.N.Levine –Quantum chemistry,Prentice Hallof IndiaPvtLtd, 1994.
2. R. K. Prasad– Quantum chemistry, WileyEasternLtd, (1992).
3. W.J. Moore- Physicalchemistry, (1962).
4. W. Castellan- Physicalchemistry, (1971).
5. A. K.Chandra-Introductory quantum chemistry.
6. P. W. Atkins- Physical chemistry.

7. S. Glasstone- Electrochemistry.
8. GordonM.Barrow-Physical Chemistry,McGrawHill PublishingCompany Ltd,2007.
9. Bockris and Reddy,ModernElectrochemistry(Vol.I&II)

Course Code and Title: 23H – Pharmaceutical Biotechnology

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

Preamble: The course designed to make students understand the concepts and process involved in pharmaceutical industry. Acquire knowledge on involvement of nanoparticles in pharmaceutical industry is the prime focus.

Prerequisite: Get equipped with theoretical knowledge of nanoparticles and its importance in pharmaceutical applications

Course Objectives: Pharmaceutical Biotechnology is intended to provide the student with a working knowledge of the preparation, stability and formulation of different protein and peptide drugs such as antisense agents, transgenic therapeutics and gene therapy. Current FDA approved biotechnology drugs such as human insulin, growth hormones and interferons will be discussed

Course Outcomes: On the successful completion of the course, students will be able to

CO1: the students will get an overall understanding of pharmacodyanamics and drug screening process

CO2: to deal with basic drug design procedures and molecular modification procedures of lead compounds

CO3: to get equipped with the theoretical understanding of active site determination of enzymes

CO4: to provide information on various types of drugs obtained from bacteria, plants, animals and insects and its active principles

CO5: to educate the active animal model systems for drug testing and protein modelling by computer using docking studies

CO6: to provide basic information on drugs derived from natural sources specifically from plants species

CO7: to educate the students to know different nanoparticles used as drug carriers and its applications

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, and Vincristine. Cardiotonic– Convallatoxin, Acetyldigoxin, Adoniside, Anti-inflammatory – Aescin, Bromelain, Local anaesthetic – Cocaine, Choleretic – Curcumin, Cynarin, Topical antifungal – Thymol, Antihypertensive, tranquilizer – Rescinnamine, Reserpine, Rhomitoxin.

Unit-V - Nanoparticles 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 – Nano carriers 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 – Nanoparticle Carriers for Ocular Drug Delivery – Nanoparticles and Microparticles as Vaccines Adjuvants

References

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2. Pharmaceutical Biotechnology, DaanCrommelin, Robert D Sindelar, 2002, Tailor and Francis Publications, New York, 2002.
3. Hand book of Pharmaceutical Biotechnology, Jay P Rho, Stan G Louie, 2003, Pharmaceutical products press, New York, 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'sPharamaceutial sciences, Joseph Price Remington, 18thedtion, Mack publishing & Co., Easton, 1980.
6. Nanoparticles as Drug carriers, Vladimir P Torchilin, Imperial College Press, USA, 2006
7. Nanomedicine, ParagDiwan and AshishBhardwaj, pentagon press, India, 2006.

Course Code and Title: 2EA – Advanced Materials Science

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

Preamble: The course intends to present new, relevant and advanced topics within modern materials science and engineering. Special lectures will be given on current research topics such as semiconductor low-dimensional structures and photonic crystals. This course aims to establish fundamental concepts in condensed matter physics with special focus on materials science, and applies the physics learned previously (in particular quantum mechanics, classical mechanics, electromagnetism and statistical mechanics) to these real-world materials.

Prerequisite: Basic knowledge in Materials Science

Course Objectives

- To learn the fundamental principles underlying and connecting the structure, processing, properties, and performance of materials systems.
- To study some of the basic properties of the condensed phase of matter especially solids.
- Have an understanding of the magnetic properties of condensed matter;
- Knowledge of the optical properties of solids and the relation to their electronic properties;
- Will study the physical principles for different types of electric and magnetic phenomena in solid materials (like e.g. ferroelectricity, superconductivity, paramagnetism, diamagnetism, ferromagnetism etc.) and in relevant cases relate this to macroscopically measured physical quantities.

Course Outcome

CO1: Will be able to demonstrate advanced knowledge and skills in materials science
CO2: Know the fundamental science and engineering principles relevant to materials
CO3: Understand the relationship between nano/microstructure, properties and processing and design of materials.
CO4: Will be able to solve theoretical problems in materials science
CO5: Gain knowledge and understanding of the properties of condensed materials.
CO6: Apply key analysis techniques to typical problems encountered in the field

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 Penetration depth – Type I and Type II Superconductors - Coherence length – BCS theory – Flux quantization – Theory of DC and AC Josephson effect – Potential applications of superconductivity.

Unit –V - Optical and Thermal Properties of Materials

Absorption processes- Photoconductivity – Photoelectric effect – Photovoltaic effect – Photoluminescene – Colourcentres – Types of colourcentres – Generation of colourcentres. 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 Young's 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

Preamble: A Nanoscience and Technology (with biotechnological) student needs to have some basic definition of energy and environment. Non – conventional energy sources from hydroelectric, tidal, ocean, thermal energy, solar energy collectors, nuclear energy and bioenergy. Definition, causes, effects and control measures of pollutions. Sources and management problems such as ozone depletion, acid rain and green house effects.The main objective of this course is to introduce the principles of conservation and application of biotechnology. Waste water treatment, characterization and its significance. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries. Based on this course aims to giving adequate exposure in the fate and life cycle of nanomaterial in environment, environmental and health impacts of nanomaterials.

Prerequisite: Higher Secondary Level, Degree Level – Environmental pollution, Waste water treatment and environmental problems such as acid rain and greenhouse effect.

Course Objectives:

- To understand the environmental problems and control measures of pollutions, greenhouse effect and acid rain.
- To understand the application of industrial ecology to nanotechnology such as environmental and health impacts of nanomaterials.
- To gain a thorough understanding of the basic knowledge of environmental biology applications related to nanoscience and nanotechnology.

Course Outcomes:

CO1: Understand the existing and emerging technologies that are important in the area of environmental biotechnology.

CO2: Understand the biotechnological solutions to address environmental issues including pollution, mineral resource winning, renewable energy and water recycling.

CO3: Understand the microbial processes and growth requirements underlying the activated sludge process, nitrification, denitrification, enhanced phosphorus removal, and anaerobic digestion.

CO4: Understand the bases for microbial metabolism of environmental contaminants.

CO5: Identify the ever-increasing complexity and interrelated nature of current environmental problems as well as the advantages of biotechnological treatment of liquid, solid and gaseous waste.

CO6: Use skills to tackle the problems and apply scientific principles to invent biotechnologies such as biological treatment, bioremediation and bio sorption that would provide solutions to the real-life problems.

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 pollution: Definition, causes, effects and control measures of Air pollution, water pollution, Soil pollution, Marine pollution and Noise pollution. Solid waste: Sources and management (composting, vermiculture and methane production).

Unit-II

Global environmental problems: ozone depletion, greenhouse effect and acid rain, principles of conservation and application of biotechnology, remote sensing and GIS, ecological modeling, bioindicators and biosensors for detection of pollution. 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-III

Waste water characterization and its significance: COD, BOD, Inorganic constituents, solids, biological components.Biochemistry and microbiology of inorganic phosphorus and nitrogen removal.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.

Unit-IV

Anaerobic digestion, anaerobic filters, up flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries. Xenobiotics-Ecological considerations, degradative plasmids; hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides, biopesticides and bioremediation of contaminated soils and wastelands.

Unit-V

Application of industrial ecology to nanotechnology: Fate and life cycle of nanomaterial in environment, environmental and health impacts of nanomaterials, toxicological threats, eco-toxicology, exposure to nanoparticle – biological damage, threat posed by nanomaterials 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 McGraw 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, McGraw 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-JoachinJordening and Josef Winter, Winter-VCH, 2005
10. Biology of wastewater Treatment, N F Gray, McGraw Hill, 2004.
11. Environmental Biotechnology: Principles and Applications, Bruce Rittmann and Perry McCarty, McGraw Hill, 2001.

12. Enviro-nanotechnology by Mao Hong fan, Chin-pao Huang, Alan E Bland, Z Honglin Wang, RachidSliman, Ian Wright. Elsevier, 2010.
13. Nanotechnologies, Hazards and Resource efficiency by M. Steinfeldt, Avon Gleich, and U. Pets chow, R. Haum. Springer, 2007.
14. Nanotechnology: 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**

Preamble: This course provides the hands on experience to understand the concepts learned through the core papers from their respective subjects in addition to nanoscience.

Prerequisite: Basic knowledge in science(physics, chemistry, biology and mathematics)

Course Objectives: Through this course the students will improve their practical knowledge in their core subjects in addition to nanoscience.

Course Outcomes: On completion of this course, students will be able to:

CO1: Understand the core concepts in physics, chemistry and biology related to nanoscience.
CO2: Have strong laboratory skills.
CO3: Enhance the present day requirements in research in their respective core subjects.
CO4: Create the knowledge of theories involved in their core subjects using practical experiments.

First Half

1. Study the forward and reverse characteristics of a Zener diode.
2. Construction of adder, subtractor, 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. Semi micro 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, characterization 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 spectra.
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. Photo polymerization
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 immune diffusion

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

Course Type:Core 10 **Semester: III** **Credits: 4**

Course Objective:

- To provide the students to understand the fundamental principles, concepts pertaining to material characterization
- To apply for the analysis of structure, optical, mechanical, chemical composition thermal magnetic and electrical properties of the materials.
- To analyse and apply for designing of new materials with multifunctional properties

Course Outcome:

After learning this course the students can able

CO1: To understand the fundamental concepts and techniques used in material characterization.
CO2: To understand principle of XRD and apply for analyzing the structural parameters
CO3: To explain and apply RAMAN and FTIR spectroscopy to evaluate materials properties
CO4: To understand and analyze the microscopic and elemental properties
CO5: To understand and apply various spectroscopy method to identify the chemical composition and stoichiometry of the materials.
CO6: To understand and analyze the electrical and magnetic properties of the materials
CO7: To understand and analyze the thermal and optical properties of the materials

CO8: To understand the basic concepts of nuclear magnetic and electron spin resonance apply for analyzing the chemical environment.

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; Nuclear Techniques: Nuclear Magnetic Resonance (NMR) – Electron Spin resonance (ESR) – Mossbauer 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 – Nanoindentation 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/Differential 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, GuozhongGao, Imperial College Press (2004).
4. Nanotechnology - Enabled Sensors, KouroshKalantar-zadeh and Benjamin Fry, Springer (2008).
5. Nanochemistry, G. B. Sergeev, Elsevier (2006).
6. Nanotechnology: Basic Science and Emerging Technologies – Mick Wilson, KamaliKannangara, Geoff Smith, Michelle Simmons, BurkhardRaguse, Overseas Press (2005).
7. Nanocomposite Science and Technology, PulickelM.Ajayan, Linda S.Schadler, Paul V.Braun, Wiley-VCH Verlag, Weinheim (2003).

Course Code and Title: 33B -Nanobiotechnology

Course Type: Core 11 **Semester: III** **Credits: 4**

Preamble: Nano-biotechnology is the science dealing with biological entities of nanometers in dimensions as the size of the objects scale down to the nanometer regime, the property will undergo transformations, present in a great potential for promising applications.

Prerequisite: Basic Concepts of Biological processes and molecular biology

Objectives:

- This course module caters multidisciplinary students to learn about biological principals.
- The Nano-biotechnology course provides knowledge on biomimetic nanostructures present in the nature.
- This syllabi enriches the knowledge about biotechnological tools to the students.
- The transformation of properties at nano scale from macro scale will be thought to the students.
- The students will learn the mechanism behind the biological functions.

Course Outcome:

On the successful completion of the course,

CO1: Students will have skills and knowledge to explain the fundamental principle of nanobiotechnology and their applications.

CO2: It will provide basic knowledge at the interface between chemistry, physics and biology on the nanostructured level with a focus on biotechnological research.

CO3: Evaluate applications of various concepts & techniques of nano-biotechnology to facilitate biotechnological advancement and innovations.

CO4: This course will act as a bridge between students from non-biology course at all levels.

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 Characterizing Membranes - Protein–Lipid Assembly - Applications of Biomimetic Membranes

Unit-II Functionalized 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 Nano machines: Introduction - Force and Motion by Directed Assembly of Actin Filaments - Molecular Motors: Myosin and Kinesins - ATP Synthase.

Unit-III Methods of Nanobiotechnology:

Optical tools – Nano force 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 – Bio integrating 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. M.Sc. Nanoscience & Technology (UD) 2015-16 onwards Annexure No.84A Page35 of 43 SCAA Dt.24.04.2015
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, KamaliKannangara, Geoff Smith, Michelle Simmons, BurkhardRaguse, Overseas Press, 2005.
7. Nanobiotechnology: Concepts, Applications and Perspectives, Christof M.Niemeyer, Chad A.Mirkin, Wiley-VCH, Weinheim, 2004.
8. Bio nanotechnology: 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 12 **Semester: III** **Credits: 4**

Preamble: This course helps the students to understand the different Micro and Nano fabrication techniques and their usages towards the development of MEMS and NEMS devices.

Prerequisite: Basic knowledge in material science and electronics. Additional knowledge in the methods to prepare nanomaterials and thin films.

Course Objectives:

Through this course the students will:

- Learn about microfabrication and their basic needs
- Understand the Micro and Nano fabrication process to develop MEMS and NEMS.
- Acquire essential knowledge about the materials used in MEMS and NEMS fabrication.
- Learn about the basic MEMS and NEMS devices.
- Get basic knowledge on the clean room

Course Outcomes:

On completion of this course, students will be able to:
CO1: Design the process to develop the specific Micro-structure by microfabrication process.
CO2: Work with different micro and nanofabrication methods
CO3: Select the essential materials for the specific need in Micro fabrication Process.
CO4: To develop MEMS and NEMS devices
CO5: Work on the Clean room atmosphere without any mistakes.

Unit-I –Microfabrication:

Moore's 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

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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 13 (for Physics) Semester: III Credits: 4 60 hours

Course Objective:

- To learn the fundamental principles of electrostatics and magnetostatics.
- To study some basic laws on magneto and electrostatics.
- To gain knowledge on electrodynamics and electromagnetic waves.
- Will study the application of electromagnetic waves in plasma physics.

Course Objective:

CO1: Summarizes the fundamentals of electrostatics and magnetostatics.
CO2: Analyse the concept of electrodynamic fields
CO3: Apply the concept of electromagnetic theory in electromagnetic waves.
CO4: Understand the transverse behavior of electromagnetic waves in different geometrics of wave guides
CO5: Formulate electromagnetic wave equations for different propagating media and to determine the flow of energy and wave velocity.

Unit-I Electrostatics:

Coulomb's law – surface, line and volume charge distributions - Gauss Law and its applications; Electrostatic potential - Laplace and Poisson equations – Potential of a localized 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 Magneto statics 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 coordinates

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

Course Type: Core 13 (for Chemistry) **Semester: III** **Credits: 4**

Preamble: To enable the students to learn the basic concept and reactions of inorganic Co-ordination compounds and how they are used in various complex formations and their applications.

Prerequisite: Students must have studied Inorganic Chemistry courses during B. Sc course.

Course Objectives:

- To enhance the level of understanding of bonding and co-ordination compounds.
- To learn crystal field stabilization energy.
- To enable students to apply the concepts of Jahn-Teller distortion - molecular orbital theory for various complex.
- Understand the reactions of co-ordination compounds.
- To analyse the complexes of Biochemical and their Importances**.**

Course Outcomes:

At the end of the course the students should be able to:

CO1: Students will be able to understand the formation coordination complexes with various theories.

CO2: Students will be able to analysis electronic spectra of coordination compounds –using Orgel and Tanabe – Sugano spectra.

CO3: Students will know how to synthesize inorganic materials and analyze them using various analytical instruments.

CO4: Students will be Identified the structure and bonding aspects of various metal carbonyl compounds.

CO5: Students will be prepared carbocyclic π –Complexes**.**

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 dn 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 V3+(oct) and Ni2+(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) – Arenecomplexes : 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*: Hydro formylation, Carbonylation of methanol and methyl acetate, 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, 6th edition, 2007.
3. Mechanism of Inorganic reactions - F. Basolo and R. G. Pearson, 2nd edition, 2008.
4. Inorganic Chemistry J.D.Lee, 5thedition, 2008.

Course Code and Title: 33F – Toxicology

Course Type: Core 13 (for Biotechnology) **Semester: III** **Credits: 4**

Preamble: The present course content is designed to provide the Basic concepts of toxicology subject deals with toxic effect on living organisms. We discuss the different types of toxicity testing methods (parameters), mechanism of toxicity inside the cells, toxic effects of chemicals and toxicology of nanoparticles at different sizes.

Perquisite: For pursuing this course, students are required to be familiar with the following concepts: Basic concepts of cell biology, anatomy, physiology, mechanism of any drug and its metabolism.

Course Objectives:

- To understand the chemical property which modulate the toxicants.
- Explain the science underlying the ability of toxic chemicals to elicit adverse human health effects
- To understand the significance of biotransformation reactions as a determinant of the toxicokinetic and toxicodynamic activities of chemicals.
- To gain a thorough understanding of the basic knowledge of Ecotoxicology, biomarkers, dosimetry and Integrated Concept of Risk Assessment of Nanoparticles at different sizes.

Course Outcomes:

CO1: Knowledge of sources, levels and mechanisms of action for toxic substances.
CO2: Understanding of exposure, uptake, metabolism, distribution and excretion of toxicants.
CO3: Knowledge of effects of toxic substances on molecular and cellular levels, on individual health and on natural populations and communities, including the use of biomarkers.
CO4: Knowledge of ecotoxicology, environmental pollution, oil effects, pharmaceutical toxicology, as well have an overview of different categories of toxic substances.
CO5: Upon completion of the course, the student should have an understanding of basic principles in ecotoxicology and toxicology.

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 M.Sc. Nanoscience & Technology (UD) 2015-16 onwards Annexure No.84A Page**39** of **43** SCAA Dt.24.04.2015Francis, 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**

Course Objectives:

- To understand the basic concepts involve in this technology for device architecture and interface engineering at atomic level.
- To provide general introduction to different types of conventional and novel devices for different applications
- Understand the underlying physical processes governing the operation of sensors.
- Demonstrate biomedical applications of nanomaterials
- To study the applications of nanomaterials for photonic and food packaging materials.

Course Outcomes:

CO1: Understanding of static and dynamic characteristics of sensors and sensor fabrication and the influence of nanostructure on functional properties.
CO2: The influence of size and shape on the energy conversion and storage materials.
CO3: Complete overview of nanomaterials for diverse biomedical applications.
CO4: Creating knowledge on single electronic devices for various applications.
CO5: Applications of nanomaterials for environmental friendly food packaging materials.

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 Bio nanostructures - 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 – Nanophotonics crystals – Nanoelectronics devices: Quantum dots – Resonant tunneling devise – 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, KouroshKalantar-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 VoDinh, CRC Press, 2007.
4. Military Nanotechnology: Potential Applications and Preventive Arms Control, Jürgen Altmann, Routledge, Taylor and Francis Group, 2006.
5. Nanotechnologies in Food, QasimChaudry, Laurence Castle and Richard Watkins, RSC Publications, 2010.
6. Recent Trends in Fuel Cell Science and Technology, Edited by SuddhasatwaBasu, Springer (2007).
7. Nanomedicine, Vijay K. Varadan, Linfeng Chen, JiningXie, 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: core 14 Practical Semester: III Credits: 4

Course Objectives:

- To impart training in operating different instruments used in the analysis of various, physical, chemical, and biological constituents.

Course Outcome:

- Students will know how to design an experiment and analyse different substances by using various analytical instruments.

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, rastamdEbullioscopy
18. Phase rule - transition temperature, C.S.T., eutectic, compound formation partition
19. Heat of neutralisation, combustion
20. Drug administration methods

Core 15 -Mini Project and Study Tour

CourseCode andTitle: 4 3 A -IPR and Biosafety

CourseType: Core (Self-study) **Semester:IV** **Credits: 2**

Preamble: To enable the students to acquire the elemental knowledge about patent and the process of patenting. To make the students to get familiarize in the concepts of international patenting, recent amendments and financial assistance etc. To understand the principles of Biosafety and its importance, genetically modified organisms and its risk management.
Prerequisite: Acquire knowledge on basics of IPR and Biosafety Concepts

Course Objective:

- To understand the basic concepts of IPR and Biosafety concepts and its application in different levels
- To acquire knowledge on the process of patenting and its database searches, analysis and its report formation
- To know about IPR policy, Indian and International Laws on patent
- To acquire knowledge on Biosafety and its significance in different areas of science

Course Outcomes:

On the successful completion of the course, students will be able to
CO1: The students will get an overall understanding of basic history and classification of patenting
CO2: Learning the techniques to obtain database search in different portals and its analysis
CO3: To get equipped with the theoretical and practical understanding of patent writing, filling patent application and related structure and frames
CO4: To know the national and international laws of IPR
CO5: To learn about biosafety cabinets, principles and its guidelines
CO6: To provide basic information on GMO s and its risk management procedures to make the environment healthy.

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 biotechnology. 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 Background; 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 Vive - Voce
