COURSE STRUCTURE

for

B.Sc. (Chemistry)
(Eight Semester 2020-21)

Programme

Based on

UGC-CBCS System
(As per Ordinance-14A)

DEPARTMENT OF CHEMISTRY

AWADHESH PRATAP SINGH UNIVERSITY, REWA (M.P.)

Semester Course

B.Sc. (Hon's) Chemistry

PROGRAMME OBJECTIVES & STRUCTURE

PO #	PROGRAMME OUTCOME
PO 1	**Critical Thinking**: Take informed actions after identifying the assumptions that frame our thinking and actions, check out the degree to which these assumptions are accurate and valid, and look at our ideas anddecisions(intellectual,organizational,andpersonal)fromdifferent Perspectives.
PO 2	**Effective Communication**: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and Technology.
PO 3	**Social Interaction**: Elicit views of others, mediated is agreements and help reach conclusions in group settings.
PO 4	**Effective Citizenship**: Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO 5	**Ethics**: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO 6	**Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development.
PO 7	**Self-directed and Life-long Learning**: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

PROGRAMME SPECIFIC OUTCOME

PSO #	PROGRAMME SPECIFIC OUTCOME
PSO 1	To gain a functional knowledge of theoretical concepts and experimental aspects of chemistry and their applications in the day-to-day life.
PSO 2	To integrate the gained knowledge with various contemporary and evolving areas in chemical sciences like inorganic, organic, physical, analytical, synthetic, instrumental etc.
PSO 3	To understand, analyze, plan and implement qualitative as well as quantitative analytical synthetic and phenomenon-based problems in chemical sciences.
PSO 4	Provide opportunities to excel in academics, research or Industry.

Course Outcome (COs)

S.No.	Course Name	Course Code
Semester-I		
	Inorganic Chemistry-I	**101**
	Course Outcome	
CO1	Understand atomic structure	
CO2	Understand periodicity of elements	
CO3	Discuss ionic bonds	
CO4	Understand covalent bond	
CO5	Concept of metallic bond and weak chemical forces	
	Calculus (For students with Mathematics in 10+2)	**102**
	Course Outcome	
CO1	Understand sequences and integration	
CO2	Evaluate limit and continuity	
CO3	Examine differentiability	
CO4	Explain expansions of functions	

CO5	Understand curvature, asymptotes and curve tracing	
Bio-molecules (For students with Biology in 10+2)		**102**
Course Outcome		
CO1	Understand carbohydrates	
CO2	Understand amino acids	
CO3	Discuss lipids	
CO4	Explain nucleic acids	
CO5	Understand vitamins	
Mathematical Methods in Chemistry		**103**
Course Outcome		
CO1	Explain fundamentals of mathematics	
CO2	Discuss uncertainties in measurement	
CO3	Understand mathematical series	
CO4	Discuss differential calculus	
CO5	Explain integral calculus	
English Communication		**104**
Course Outcome		
CO1	To enhance all the four communication skills in the students-- listening, speaking, reading and writing	
CO2	To familiarize the students with the nature and importance of effective communication skills in their professional life	
CO3	To make the students capable of actively participating in various individual/group communications such as group discussion, debate, meeting, presentation etc	
CO4	To enrich the vocabulary of the students to make them efficient communicators	
CO5	To strengthen the Grammar of the students	
Inorganic Chemistry Lab		**105**
Course Outcome		
CO1	Estimation of carbonate and hydroxide present together in mixture	

CO2	Estimation of free alkali present in different soaps/detergents	
CO3	Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution	
CO4	Estimation of oxalic acid and sodium oxalate in a given mixture	
CO5	Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator	
Bio-molecules		**106**
Course Outcome		
CO1	Qualitative analysis of biomolecules	
CO2	Carbohydrates-Molisch, Benedict's, Fehling's, picric acid, Barfoed's, Bial's, Seliwanoff's, osazone tests	
CO3	Proteins- Precipitation reactions of proteins, colour reactions of proteins, colour reactions of amino acids like tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine	
CO4	Colour reactions of proteins- Biuret, xanthoproteic, Millon's	
CO5	Lipids-solubility, acrolein test, Salkowski test, Lieberman-Burchard test	
Semester-II		
	Organic Chemistry	**201**
	Course Outcome	
CO1	Understand basics of organic chemistry	
CO2	Understand stereochemistry	
CO3	Understand chemistry of aliphatic hydrocarbons	
CO4	Understand carbon-carbon pi-bonds	
CO5	Determine cycloalkanes and conformational analysis	
Algebra and Geometry (For students with Mathematics in 10+2)		**202**
	Course Outcome	
CO1	Explain theory of equations and complex numbers	
CO2	Explain relations and basic number theory	

CO3	Understand row echelon form of matrices and applications	
CO4	Understand planes, straight lines and spheres	
CO5	Understand locus, surfaces, curves and conicoids	
Cell Biology (For students with Biology in 10+2)		**202**
	Course Outcome	
CO1	Understand introduction of cell	
CO2	Understand structure and function of sub-cellular organelles	
CO3	Explain cell fraction techniques	
CO4	Understand cell wall	
CO5	Explain cell cycle and cell division	
Life Science/ Biology-I		**203**
	Course Outcome	
CO1	Understand Cell and cellular processes	
CO2	Understand Cell organelles	
CO3	Explain nuclear envelope	
CO4	Explain Cell cycle	
CO5	Understand the instrumentation techniques	
Environmental Science		**204**
	Course Outcome	
CO1	Have knowledge of the Modern fuels and their environmental impact – Methanogenic bacteria	
CO2	Comprehend the Structural and Functional dynamics of microbes, their diversity	
CO3	Have knowledge of treatment of municipal waste and Industrial effluents, Biofertilizers	
CO4	Have basic understanding of Enrichment of ores by microorganisms	
CO5	know about Methanogenesis: methonogenic, acetogenic and fermentive bacteria	
Organic Chemistry Lab		**205**
	Course Outcome	

CO1	Understand calibration of thermometer	
CO2	Understand purification of organic compounds	
CO3	Understand melting point	
CO4	Determination of point mixed melting point of two unknown organic compounds	
CO5	Determine separation of a mixture of two amino acids	
Cell Biology Lab		**206**
	Course Outcome	
CO1	Understand microscope	
CO2	Cytochemical staining of proteins	
CO3	Study of stages of mitosis	
CO4	Study of stages of meiosis	
CO5	Study of cell organelles	
Semester-III		
Physical Chemistry-I		**301**
	Course Outcome	
CO1	Understand behavior of real gases	
CO2	Discuss Chemical kinetics	
CO3	Discuss liquid state	
CO4	Analyse ionic equilibrium	
CO5	Explain solid state	
Partial Differential Equations and Calculus of Variations		**302**
	Course Outcome	
CO1	Discuss first order partial differential equations	
CO2	Discuss second order partial differential equations with constant coefficients	
CO3	Discuss second order partial differential equations with variable coefficients	
CO4	Explain calculus of variations-variational problems with fixed boundaries	
CO5	Explain calculus of variations-variational problems with moving boundaries	
Human Physiology		**302**
	Course Outcome	
CO1	Discuss the Nervous System	

CO2	Discuss Excretory System	
CO3	Understand Body Fluids	
CO4	Understand Endocrine System	
CO5	Understand Digestive System	
Fundamentals of Computers		**303**
Course Outcome		
CO 1	Explain Introduction of Computer	
CO 2	Discuss Devices	
CO 3	Explain Human Computer Interface	
CO 4	Understand Computer Networks	
CO 5	Understand Internet	
Bio-fertilizers		**304**
Course Outcome		
CO 1	Understand Microbes as fertilizers	
CO 2	Explain Azospirillum and Azotobacter	
CO 3	Understand Blue green algae, phosphate solubilising microbes	
CO 4	Understand Mycorrhizal effect on plant growth	
CO 5	Understand Microbial use in bioinsecticides and biocompost	
Physical Chemistry Lab		**305**
Course Outcome		
CO 1	Determination the surface tension	
CO 2	Study the variation of surface tension of detergent solution with concentration	
CO 3	Explain viscosity measurements using Ostwald's viscometer	
CO 4	Preparation of buffer solutions of different pH	
CO 5	Determination of dissociation constant of a weak acid	
Human Physiology Lab		**306**
	Course Outcome	
CO1	Preparation of blood smear and differential leucocyte count.	
CO2	Estimation of Hemoglobin	

CO3	Estimation of Uric acid	
CO4	Understand Iron by Wong's method	
CO5	Understand qualitative analysis of Urine-detection of urea	
Semester-IV		
Organic Chemistry-II		**401**
Course Outcome		
CO1	Understand Alkyls halides	
CO2	Understand Aryl halides	
CO3	Discuss Alcohols, Phenoles, Ethers and Epoxides	
CO4	Discuss Carbonyl Compounds	
CO5	Explain Carboxylic acids and their derivaties	
Probability and Statistics		**402**
	Course Outcome	
CO1	Discuss Probability and Random Variables	
CO2	Understand Univariate distributions	
CO3	Discuss Bivariate distributions	
CO4	Understand Correlation and Regression	
CO5	Discuss Information Theory	
Biochemistry of Enzymes		**402**
Course Outcome		
CO 1	Explain Enzymes and Classification	
CO 2	Discuss Characterization of Enzymes	
CO 3	Discuss Mechanism and Allosteric Enzymes	
CO 4	Understand Isoenzymes	
CO 5	Understand Applications of Enzymes	
Elements of Modern Physics		**403**
Course Outcome		
CO 1	Explain Basic knowledge of physics	
CO 2	Understand Position measurement	
CO 3	Understand size and structure of atomic nucleus	
CO 4	Understand Radioactivity	

CO 5	Discuss Fission and Fusion	
Environmental Impact Analysis		**404**
Course Outcome		
CO 1	Understand Origin and Development	
CO 2	Discuss EIA Process	
CO 3	Learn main participants in EIA Process	
CO 4	Understand Environmental Appraisal and Procedures in India and EIA	
CO 5	Discuss EIA notification September 2006 and amendments	
Organic Chemistry Lab		**405**
Course Outcome		
CO 1	Explain functional group test	
CO 2	Organic preparation	
CO 3	Oxidation of ethanol (Iodoform reaction)	
CO 4	Understand hydrolysis of amides and esters	
CO 5	Aldol condensation with either conventional of green method	
Biochemistry of Enzymes Lab		**406**
Course Outcome		
CO 1	Isolation of urease and demonstration of its activity	
CO 2	Purification of urease	
CO 3	Time course of urease reaction	
CO 4	Determination of initial velocity of salivary amylase	
CO 5	Determination of optimum temperature of salivary amylase	
Semester-V		
Physical Chemistry-II		**501**
Course Outcome		
CO1	Discuss introduction of thermodynamics	
CO2	Understand Thermochemistry	
CO3	Discuss Second and third law of thermodynamics	
CO4	Understand free energy functions	

CO5	Discuss partial molar quantities	
Polymer Chemistry		**502**
Course Outcome		
CO1	Discuss introduction of polymer	
CO2	Understand polymeric structure and property relationship	
CO3	Understand polymerization chemistry	
CO4	Understand characterization of polymers	
CO5	Discuss glass transition temperature and determination of T_g	
Advanced Analytical Chemistry		**502**
Course Outcome		
CO1	Understand statistical methods in chemical analysis	
CO2	Understand polarography	
CO3	Understand thermal analysis	
CO4	Understand Chromatography	
CO5	Discuss analysis of fuel and drugs	
Analytical Clinical Biochemistry		**503**
Course Outcome		
CO1	Understand Carbohydrates	
CO2	Understand Proteins	
CO3	Understand Lipid	
CO4	Understand Structure of DNA and RNA	
CO5	Discuss Blood and Formation of Urine	
Physical Chemistry Lab		**505**
	Course Outcome	
CO1	Determination of critical solution temperature and composition of the phenol-water system	
CO2	Study the equilibrium	
CO3	Study the kinetics	
CO4	Saponification of ethyl acetate	
CO5	Verification of Freundlich and Langmuir isotherms for adsorption	
Semester-VI		
Molecular Spectroscopy and Photochemistry		**601**

	Course Outcome	
CO1	Understand electromagnetic radiation and rotation spectroscopy	
CO2	Understand vibrational spectroscopy	
CO3	Explain Raman spectroscopy	
CO4	Understand Electronic spectroscopy	
CO5	Explain Photophysical and photochemical processes	
Medicinal Chemistry		**602**
	Course Outcome	
CO1	Understand Bio-physicochemical properties	
CO2	Understand Structural properties	
CO3	Explain Drug target understanding and medicinal chemistry of therapeutic agent	
CO4	Explain Steroids, Prostaglandins, enzyme, hormone and vitamins	
CO5	Understand Concept of rational drug design	
Electrochemistry		**602**
	Course Outcome	
CO1	Understand electrochemistry of weak and strong electrolyts-I	
CO2	Understand electrochemistry of weak and strong electrolyts-II	
CO3	Discuss electrochemical laws of electrolysis	
CO4	Explain Electroanalytical methods	
CO5	Discuss electrical & magnetic properties of atoms and molecules	
Organometallic and Bioinorganic Chemistry		**603**
	Course Outcome	
CO1	Understand chemistry of 3d metals	
CO2	Understand organometallic compounds	
CO3	Understand metal carbonyls	
CO4	Discuss Zeise's salt	
CO5	Explain Ferrocene and bioinorganic chemistry	
Organic Spectroscopy		**603**
	Course Outcome	
CO1	Understand basic principles of UV Spectroscopy	

CO2	Understand UV spectroscopy	
CO3	Explain basic principles of IR spectroscopy	
CO4	Discuss NMR	
CO5	Understand basic principles of mass spectrometry	
Molecular spectroscopy and photochemistry		**605**
Course Outcome		
CO1	Determination of indicator constant-colorimetry	
CO2	Verification of Beer's Law	
CO3	Determination of concentration of solution by colorimetry	
CO4	Interpretation of IR spectra	
CO5	Interpretation of Uv-visible spectra	
Semester-VII		
Green Chemistry		**701**
	Course Outcome	
CO1	Discuss Introduction of Green Chemistry	
CO2	Discuss principles of green chemistry and designing a chemical synthesis	
CO3	Discuss Green synthesis/reaction I	
CO4	Discuss Green synthesis/reaction II	
CO5	Understand future trends in green chemistry	
Environmental Chemistry		**702**
	Course Outcome	
CO1	Discuss Environment	
CO2	Discuss hydrosphere	
CO3	Discuss Atmosphere	
CO4	Explain Aquatic chemistry	
CO5	Explain Municipal water treatment processes	
Nuclear and Radiation Chemistry		**702**
	Course Outcome	
CO1	Discuss Introduction of Nuclear and Radiation Chemistry	
CO2	Discuss Nuclear Reaction	
CO3	Understand Radioactivity and Types of Reactions	

CO4	Understand Radiation Chemistry	
CO5	Understand Nuclear Pollution and Radiological Safety	
Research Methodology		**703**
Course Outcome		
CO 1	Explain basic concepts of Research	
CO 2	Discuss Data Collection and Documentation of Observations	
CO 3	Overview of application to chemistry related problems	
CO 4	Understand Ethics and good practical's	
CO 5	Understand Art of Scientific Writing	
Green Chemistry Lab		**705**
Course Outcome		
CO 1	Preparation and characterization of nanoparticles of gold using tea leaves	
CO 2	Preparation of biodiesel from vegetable/waste cooking oil	
CO 3	Benzoin condensation using Thiamine hydrochloride as a catalyst	
CO 4	Solvent free, microwave assisted one pot synthesis of phthalocyanine Cu(II) complex	
CO 5	Understand photoreduction of benzophenone to benzopinacol in presence of sunlight	
Semester-VIII		
Analytical Chemistry		**801**
Course Outcome		
CO 1	Understand qualitative and quantitative aspects of analysis	
CO 2	Discuss spectroscopy	
CO 3	Explain Vibration spectroscopy	
CO 4	Discuss UV-visible spectroscopy	
CO 5	Understand Thermal analysis	
Heterocyclic Chemistry		**802**
	Course Outcome	
CO1	Discuss three-membered rings with one heteroatom	
CO2	Discuss three-membered rings with two heteroatoms	

CO3	Discuss four-membered heterocycles	
CO4	Discuss five-membered atomic heterocycle	
CO5	Explain condensed five-membered heterocycles	
Introduction to Nano-Chemistry and Applications		**802**
Course Outcome		
CO1	Discuss Introduction of nanoscience	
CO2	Explain calculation of percentage of surface atom	
CO3	Explain size dependent properties of nanomaterials	
CO4	Discuss synthesis of nanomaterials	
CO5	Understand material characterization techniques	
Analytical Chemistry Lab		**801**
Course Outcome		
CO1	Explain Chromatography	
CO2	Explain solvent extractions	
CO3	Explain size analysis of soil	
CO4	Discuss ion exchange	
CO5	Explain sectrophotometry	

A.P.S. University, Rewa

B.Sc. (Hons/Research) Chemistry

Course Structure and Scheme of Examination

(UGC-CBCS System as per ordinance 14A)

Semester-I

Course code and Name	Course Type	Credits Allocated		Distribution of Theory Marks		Distribution of Practical Marks	
		Theory	Practical	Internal (Through CCE)	External (End Semester Exam)	Internal	External (End Semester Practical Exam)
101: Inorganic Chemistry-I	Major	4	2	40	60	40	60
102: Calculus[1] Biomolecules[2]	Minor	6	NA	40	60	NA	NA
		4	2	40	60	40	60
103: Mathematical Methods in Chemistry	GE-I	4	NA	40	60	NA	NA
104: English Communication	AE-I	4	NA	40	60	NA	NA
SEMESTER TOTAL		20		400		200	

[1]Calculus for the students with Mathematics in 10+2
[2]Biomolecules for the students Biology in 10+2

Semester-II

Course code and Name	Course Type	Credits Allocated		Distribution of Theory Marks		Distribution of Practical Marks	
		Theory	Practical	Internal (Through CCE)	External (End Semester Exam)	Internal	External (End Semester Practical Exam)
201: Organic Chemistry-I	Major	4	2	40	60	40	60
202: Algebra and Geometry[1] Cell Biology[2]	Minor	6	NA	40	60	NA	NA
		4	2	40	60	40	60
203: Life Science (Biology)-I	GE-II	4	NA	40	60	NA	NA
204: Environmental Science	AE-II	4	NA	40	60	NA	NA
SEMESTER TOTAL		20		400		200	

[1]Algebra and Geometry for the students with Mathematics in 10+2
[2]Cell Biology for the students Biology in 10+2

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A.P.S. University, Rewa
B.Sc. (Hons/Research) Chemistry

Course Structure and Scheme of Examination

(UGC-CBCS System as per ordinance 14A)

Semester-III							
Course code and Name	**Course Type**	**Credits Allocated**		**Distribution of Theory Marks**		**Distribution of Practical Marks**	
		Theory	**Practical**	**Internal (Through CCE)**	**External (End Semester Exam)**	**Internal**	**External (End Semester Practical Exam)**
301: Physical Chemistry-I	Major	4	2	40	60	40	60
302: Partial Differential Equation and Calculus[1]	Minor	6	NA	40	60	NA	NA
Human Physiology[2]		4	2	40	60	40	60
303: Fundamental of computers	GE-III	4	NA	40	60	NA	NA
304: Biofertilizers	SE-I	4	NA	40	60	NA	NA
SEMESTER TOTAL		20		400		200	

[1]Partial Differential Equation and Calculus for the students with Mathematics in 10+2
[2]Human Physiology for the students with Mathematics in 10+2

Semester-IV							
Course code and Name	**Course Type**	**Credits Allocated**		**Distribution of Theory Marks**		**Distribution of Practical Marks**	
		Theory	**Practical**	**Internal (Through CCE)**	**External (End Semester Exam)**	**Internal**	**External (End Semester Practical Exam)**
401: Organic Chemistry-II	Major	4	2	40	60	40	60
402: Probability and Statistics [1]	Minor	6	NA	40	60	NA	NA
Biochemistry of Enzymes[2]		4	2	40	60	40	60
403: Elements of Modern Physics	GE-IV	4	NA	40	60	NA	NA
404: Environmental Impact Analysis	SE-II	4	NA	40	60	NA	NA
SEMESTER TOTAL		20		400		200	

[1]Probability and Statistics for the students with Mathematics in 10+2
[2]Biochemistry of Enzymesfor the students with Mathematics in 10+2

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A.P.S. University, Rewa
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Course Structure and Scheme of Examination

(UGC-CBCS System as per ordinance 14A)

Semester-V							
Course code and Name	Course Type	Credits Allocated		Distribution of Theory Marks		Distribution of Practical Marks	
		Theory	Practical	Internal (Through CCE)	External (End Semester Exam)	Internal	External (End Semester Practical Exam)
501: Physical Chemistry-II	Major	4	2	40	60	40	60
502: Polymer Chemistry Or Advance Analytical Chemistry	DSE-I	4	NA	40	60	NA	NA
503: Analytical Clinical Biochemistry	SE-III	4	NA	40	60	NA	NA
504: Field Project/ Internship/ Apprenticeship	FP/IS/AS	4	2	NA	NA	40	60
SEMESTER TOTAL		20		300		200	

Semester-VI							
Course code and Name	Course Type	Credits Allocated		Distribution of Theory Marks		Distribution of Practical Marks	
		Theory	Practical	Internal (Through CCE)	External (End Semester Exam)	Internal	External (End Semester Practical Exam)
601: Molecular Spectroscopy and Photochemistry	Major	4	2	40	60	40	60
602: Medicinal Chemistry Or Electrochemistry	DSE-II	4	NA	40	60	NA	NA
603: Organometallics and Bioinorganic Chemistry Or Organic Spectroscopy	DSE-III	4	NA	40	60	NA	NA
604: Field Project/ Internship/ Apprenticeship	FP/IS/AS	6	NA	NA	NA	40	60
SEMESTER TOTAL		20		300		200	

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A.P.S. University, Rewa
B.Sc. (Hons/Research) Chemistry

Course Structure and Scheme of Examination

(UGC-CBCS System as per ordinance 14(A))

Semester-VII							
Course code and Name	**Course Type**	**Credits Allocated**		**Distribution of Theory Marks**		**Distribution of Practical Marks**	
		Theory	**Practical**	**Internal** (Through CCE)	**External** (End Semester Exam)	**Internal**	**External** (End Semester Practical Exam)
701: Green Chemistry	Major	4	2	40	60	40	60
702: Environmental Chemistry Or Nuclear and Radiation Chemistry	DSE-IV	4	NA	40	60	NA	NA
703: Research Methodology	Minor	4	NA	40	60	NA	NA
704: Field Project/ Internship/ Apprenticeship / Research Project	FP/IS/AS/RP	4	2	NA	NA	40	60
SEMESTER TOTAL		20		300		200	

Semester-VIII							
Course code and Name	**Course Type**	**Credits Allocated**		**Distribution of Theory Marks**		**Distribution of Practical Marks**	
		Theory	**Practical**	**Internal** (Through CCE)	**External** (End Semester Exam)	**Internal**	**External** (End Semester Practical Exam)
801: Analytical Chemistry	Major	4	2	40	60	40	60
802: Heterocyclic Chemistry Or Introduction to Nano-chemistry	DSE-V	4	NA	40	60	NA	NA
803: Dissertation	Minor	4	NA	40	60	NA	NA
804: Field Project/ Internship/ Apprenticeship / Research Project	FP/IS/AS/RP	4	2	NA	NA	40	60
SEMESTER TOTAL		20		300		200	

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24/11/22

Subject I
Major
Semester I
(Core)
Inorganic Chemistry-I

COURSE OBJECTIVES

On completion of this course, the students will be able to understand:

- Atomic theory and its evolution.
- Elements in periodic table; physical and chemical characteristics, periodicity.
- Identity of given element, relative size, charges of proton, neutron and electrons and their assembly to form different atoms.
- Physical and chemical characteristics of elements in various groups and periods according to ionic size, charge, etc. and position in periodic table.
- Characterize bonding between atoms, molecules, interaction and energetic, hybridization and shapes of atomic, molecular orbitals, bond parameters, bond- distances and energies.
- Valence bond theory incorporating concepts of hybridization predicting geometry of molecules.
- Importance of hydrogen bonding, metallic bonding.

Unit-I: Atomic Structure

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de' Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and $\psi 2$. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

Unit-II: Periodicity of Elements

s, *p*, *d*, *f* block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to *s* and *p*-block. Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. Atomic radii (van'der Waals), Ionic and crystal radii. Covalent radii (octahedral and tetrahedral), Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. Electron gain enthalpy, trends of electron gain enthalpy. Electronegativity, Pauling, Mullikan, electronegativity and bond order, partial charge, hybridization, group electronegativity.

Unit-III: Ionic Bonding

General characteristics, definition of ionic bonds, examples, formation of ionic bond, strength of ionic bonds, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in

crystals. Born-Landé equation with derivation, expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

Unit-IV: Covalent bond

Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone-and bond-pairs of electrons multiple bonding, sigma and pi-bond approach, Valence Bond theory, (Heitler-London approach). Hybridization containing s, p and s, p, d atomic orbitals, shapes of hybrid orbitals, Bents rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules, MO diagrams of simple tri and tetra-atomic molecules, e.g., N_2, O_2, CO, NO, and their ions; HCl, BeF_2, CO_2, Covalent character in ionic compounds, polarizing power and polarizability. Fajan rules, polarization. Ionic character in covalent compounds: Bond moment and dipole moment.

Unit-V: Metallic bonding and Weak chemical forces

Metallic Bond: Definition of metallic bond, properties and examples of metallic bonds, qualitative idea of free electron model, Semiconductors, Insulators.

Weak Chemical Forces: van'der Waals, ion-dipole, dipole-dipole, induced dipole dipole-induced dipole interactions, Lenard-Jones 6-12 formula, hydrogen bond, effects of hydrogen bonding on melting and boiling points, solubility, dissolution, intermolecular and intramolecular hydrogen bonding.

Recommended Books/References:

1. J. D. Lee, *Concise Inorganic Chemistry,* Wiley, 5th Edn.
2. B. E. Douglas, D. H. McDaniel, J. J. Alexander, *Concepts & Models of Inorganic Chemistry, (Third Edition)* John Wiley & Sons,1999.
3. P. W. Atkins, J. DePaula, *Physical Chemistry*, Tenth Edition, Oxford University Press, 2014.
4. G. E. Rodger, *Inorganic and Solid State Chemistry*, Cengage Learning, 2002.
5. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.

COURSE OUTCOMES

The students will be able to

- know the concept of wave function and wave mechanics.
- know the physical and chemical properties of elements in various groups and periods in the Periodic Table.
- Demonstrate and understanding of VSEPR theory
- To predict the atomic structure, chemical bonding and molecular geometry based on accepted models.
- To understand atomic theory of matter, composition of atom.
- Get knowledge about importance of metallic bonding and weak chemical forces.

Semester I
Practical
Inorganic Chemistry

COURSE OBJECTIVES

The students will learn

- The basics of estimation of carbonate and free alkali
- Oxidation-reduction titrimetry

Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.
(ii) Estimation of carbonate and bicarbonate present together in a mixture.
(iii) Estimation of free alkali present in different soaps/detergents

Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Recommended Books/References:

1. J. Mendham, A. I. Vogel's *Quantitative Chemical Analysis* Sixth Edition, Pearson, 2009.
2. G. Svehala, I. B. Sivasankar, Vogel's Qualitative Inorganic Analysis, Pearson, India, 2012.

COURSE OUTCOMES

The students will be able to

- Estimate cations and free alkali
- Estimate the Fe(II) and oxalic acids

Subject II
Minor
Semester I
Calculus

Course Learning Outcomes

This course will enable the students to:

- Assimilate the notions of limit of a sequence and convergence of a series of real numbers.
- Calculate the limit and examine the continuity of a function at a point.
- Understand the consequences of various mean value theorems for differentiable functions.
- Sketch curves in Cartesian and polar coordinate systems.
- Apply derivative tests in optimization problems appearing in social sciences, physical sciences, life sciences and a host of other disciplines.

Unit-I: Sequences and Integration

Real numbers, Sequences of real numbers, Convergence of sequences and series, Bounded and monotonic sequences; Definite integral as a limit of sum, Integration of irrational algebraic functions and transcendental functions, Reduction formulae, Definite integrals.

Unit-II: Limit and Continuity

$\varepsilon - \delta$ definition of limit of a real valued function, Limit at infinity and infinite limits; Continuity of a real valued function, Properties of continuous functions, Intermediate value theorem, Geometrical interpretation of continuity, Types of discontinuity; Uniform continuity.

Unit-III: Differentiability

Differentiability of a real valued function, Geometrical interpretation of differentiability, Relation between differentiability and continuity, Differentiability and monotonicity, Chain rule of differentiation; Darboux's theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Geometrical interpretation of mean value theorems; Successive differentiation, Leibnitz's theorem.

Unit-IV: Expansions of Functions

Maclaurin's and Taylor's theorems for expansion of a function in an infinite series, Taylor's theorem in finite form with Lagrange, Cauchy and Roche–Schlomilch forms of remainder; Maxima and minima.

Unit-V: Curvature, Asymptotes and Curve Tracing

Curvature; Asymptotes of general algebraic curves, Parallel asymptotes, Asymptotes parallel to axes; Symmetry, Concavity and convexity, Points of inflection, Tangents at origin, Multiple points, Position and nature of double points; Tracing of Cartesian, polar and parametric curves.

References:

1. Howard Anton, I. Bivens & Stephan Davis (2016). *Calculus* (10th edition). Wiley India.

2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
3. Wieslaw Krawcewicz & Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.
4. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd.
5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas*' *Calculus* (14th edition). Pearson Education.

COURSE OUTCOMES

- The students will be able to know the different aspect of calculus as per given content.

Subject II
Minor
Semester I
Biomolecules

Course Objective

- Exposure with the nature of various biomolecules present in living cells.
- Get exposed to key contributions of scientists such as Hans Kreb, G. N. Ramachandran, Melvin Calvin, Louis Pasteur, HarGobind Khorana, Watson and Crick and Venky Ramakrishnan, etc.in order to create scientific interest amongst students in life processes.
- To understand the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolipids and their importance in biological systems.
- To understand the process of fermentation and manufacture of Biodiesel.
- To develop skills to determine amino acid and nucleotide sequences of proteins and DNA respectively.

Unit-I: Carbohydrates

Definition, empirical formulae, classification, biological importance. Monosaccharide: Configuration relationship of D-aldoses, D-ketoses. General properties of aldoses and ketoses. Oxidation, reduction, reducing property, formation of glycosides, acylation, methylation, phenyl hydrazine reaction. Inter-conversion of aldoses and ketoses. Isomerism in monosaccharides, (+) and (-), D and L, epimers, anomers, and stereoisomers. Structure and biological importance of amino sugars, deoxy sugars, sugar acids, neuraminic and muramic acid.

Disaccharides: Establishment of structures of sucrose and lactose, biological importance and structure of isomaltose, trehalose and maltose.

Polysaccharides: Partial structure, occurrence and importance of starch, glycogen, inulin, cellulose, chitin, and pectin.

Glycosaminoglycans: Occurrence, importance and the structure, Bacterial cell wall polysaccharide, peptidoglycans.

Unit-II: Amino acids

Structure and classification of amino acids based on polarity. Reactions of the amino groups due to amino and carboxylic group, Zwitterionic properties. Peptides: Peptide bond, biologically active peptides.

Proteins: Classification of proteins based on solubility, structure and functions with examples. Primary Structure of proteins, methods of determining N- and C- terminal aminoacids, amino acid composition. Sequencing by Edman's degradation method. Secondary Structure-α Helix. β-sheet, β-bend. Tertiary of myoglobin and quaternary structure of hemoglobin, denaturation and renaturation of proteins.

Unit-III: Lipids:
Classification and biological role. Fatty acids- Nomenclature of saturated and unsaturated fatty acids. Physiological properties of fatty acids.
Acylglycerols: Mono, di and triglycerols. Saponification, saponification value, iodine value, acid value and significance.
Phosphoglycerides: Structure of lecithin, cephalins, phosphotidylinosital, plasmalogens, and cardiolipin. Biological role of phosphoglycerides.
Sphingolipids: Structure and importance of sphingomyelin. Glycosphingolipids: Structure and importance of gangliosides and cerebrosides.

Unit-IV: Nucleic acids:
DNA: Composition of DNA. Nucleosides and nucleotides. Chargaff's rule. Watson and Crick model of DNA. Types of DNA.
RNA: Composition, types (mRNA, tRNA and rRNA), secondary structures of tRNA-clover leaf model. Chemical reactions of RNA and DNA with acid and alkali, colour reactions of DNA and RNA.

Unit-V: Vitamins
Introduction and biological significance of vitamins, Water soluble vitamins, their occurrence, functions, structure, diseases, Fat soluble vitamins, their occurrence, functions, structure, diseases.

Recommended Books/References:

1. A.L., Lehninger, principles of biochemistry (1982), Worth Publishers, Inc. New York.
2. E.E. Conn and P.K. Stumpf. Outlines of Biochemistry (1976) Wiley Eastern, New Delhi.
3. Biochemistry by L. Stryer (1995) W.H. Freeman Press, San Francisco, USA.
4. Biochemistry, by Voet, D. and Voet, J.G. (2004). 3rd Edition, John Wiley & Sons, Inc. USA.

Course outcomes:

- Students will be exposed to the history of Biochemistry and key contributions of scientists such as Hans Kreb, G. N. Ramachandran, Melvin Calvin, Louis Pasteur, Hargobind Khorana, Watson and Crick and Venky Ramakrishnan.
- They will study the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolysis and their importance in biological systems.
- They will understand the process of fermentation and manufacture of Biodiesel.
- They will understand the methods of determination of amino acid and nucleotide sequence of proteins and DNA respectively.

Semester - I
Subject I
Biomolecules
Practical

Course Objective

- Exposure to basic reactions of biomolecules.
- Determine presence of biomolecules like carbohydrates, proteins, lipids, etc. in known and unknown samples.
- Determine the extent of adulteration in samples containing biomolecules.

Practical content:

1. Qualitative analysis of biomolecules
2. Carbohydrates-Molisch, Benedict's, Fehling's, picric acid, Barfoed's, Bial's, Seliwanoff's, osazone tests.
3. Glucose, fructose, lactose, maltose and sucrose.
4. Proteins- Precipitation reactions of proteins, colour reactions of proteins, colour reactions of amino acids like tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine.
5. Colour reactions of proteins- Biuret, xanthoproteic, Millon's.
6. Lipids-solubility, acrolein test, Salkowski test, Lieberman-Burchard test.
7. Qualitative tests for nucleic acid.

Course outcomes:

- The student will gain awareness about basic reactions of biomolecules and their utility in identification of adulterants.
- The student will known Glucose, fructose, lactose, maltose and sucrose.

Student will gain the skill of qualitative tests for nucleic acid and other biomolecules

Subject III
GEC
Semester – I
Mathematical Methods in Chemistry

COURSE OBJECTIVES

The objective of the course is to know the basics of the mathematics which are generally applied in chemistry viz., vectors and matrix algebra, differential and integral calculus, permutation and probability

Unit-I: Fundamentals of mathematics

Mathematical functions, polynomial expressions, logarithms, exponential function, units of a measurement, inter-conversion of units, constants and variables, equation of a straight line, plotting graphs, data representation, pi-charts, histogram. Uncertainty in experimental techniques: Displaying uncertainties and measurements in chemistry, decimal places, significant figures, combining quantities.

Unit-II: Uncertainties in measurement

types of uncertainties, combining uncertainties. Use of statistical tools, Data reduction and the propagation of errors, binomial, Poisson and Gaussian distributions, Graphical and numerical data reduction. Numerical curve fitting: the method of least squares (regression). Algebraic operations on real scalar variables, Roots of quadratic equations analytically and iteratively, Numerical methods of finding roots (Newton-Raphson, binary –bisection).

Unit-III: Mathematical series

Power series, Maclaurin, Taylor series, convergence (e.g. pressure virial equation of state, colligative properties). Pythagoras theorem in three dimensions. Trigonometric functions, identities.

Unit-IV: Differential calculus

The tangent line and the derivative of a function, numerical differentiation, differentials of higher order derivatives, discontinuities, stationary points, maximum-minimum problems, inflexion points, limiting values of functions: L'Hopital's rule, combining limits. Calculus of several variables*:* Functions, change of variables, total differential, chain rule, partial differentiation, Euler's theorem, exact and inexact differentials (applications tin the domains of thermodynamics, surface chemistry), line/surface-integrals.

Unit-V: Integral calculus

Integration, odd-even functions, indefinite integrals, standard integrals, methods of integration (by parts, substitution, partial fractions and others. Examples from kinetics, thermodynamics, nuclear chemistry and surface chemistry, numerical integration (Trapezoidal and Simpson rules,

e.g. entropy/enthalpy change from heat capacity data), probability distributions and mean values. Tri-gonometric functions (applications in chemistry need to be emphasized throughout)

Recommended Books/References:

1. Chemical Maths Book, E. Steriner, Oxford University Press (1996).
2. Maths for Chemists, Vols 1 and 2 M. C. R. Cockett and G. Dogget, Royal Society of Chemistry, Cambridge (2003).

COURSE OUTCOMES

Basic mathematics is the back bone of modern chemistry. Students from biology background are also taking admission in the Program. Hence, the course is useful in understanding topics where mathematics is involved.

Subject I
Major
Semester II
(Core)
Organic Chemistry-I

COURSE OBJECTIVES

On completion of this course, the students will be able to understand:

- Basics of organic chemistry.
- Stereochemistry of organic molecules – conformation and configuration, asymmetric molecules and nomenclature.
- Understanding hybridization and geometry of atoms, 3-D structure of organic molecules, identifying chiral centers.
- Reactivity, stability of organic molecules, structure, stereochemistry.
- Aromatic compounds and aromaticity, mechanism of aromatic reactions, carbon-carbon sigma and pi-bonds.
- Mechanism of organic reactions (effect of nucleophile/leaving group, solvent), substitution *vs*. elimination.

Unit-I: Basics of Organic Chemistry

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and relative stabilities of reaction intermediates (Carbocations, Carbanions, Free radicals and Carbenes).

Organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit-II: Stereochemistry

Concept of asymmetry, Fischer Projection, Newmann and Sawhorse projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixtures, Relative and absolute configuration: D/L and R/S designations.

Unit-III: Carbon-Carbon sigma bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz- Fittig Reactions, Free radical substitutions: Halogenation - relative reactivity and selectivity.

Unit-IV: Carbon-Carbon pi-bonds

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2- and 1, 4- addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions.

Unit-V (Cycloalkanes and Conformational Analysis)

Cycloalkanes and stability, Baeyer strain theory, Conformation analysis, Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms.

Aromatic Hydrocarbons: Aromaticity: Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of substituent groups.

Recommended Books/References:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, 6th Edn., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill, (2007)
3. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).
4. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), Oxford Universitiy Press.
5. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism, Kluwer Academic Publisher, (2000).

COURSE OUTCOMES

The students will be able to

- Acquire the skills for correct stereo-chemical assignment and interpretation in rather simple organic molecules.
- Understanding of Organic reaction, rearrangement and cross-coupling reaction with their mechanism and application.

Semester II
Practical
Organic Chemistry Practical

COURSE OBJECTIVES

To introduce organic synthesis, purification and identification of organic compounds using physiochemical techniques.

1. Checking the calibration of the thermometer.
2. Purification of organic compounds by crystallization using the following solvents:
    a. Water
    b. Alcohol
    c. Alcohol-Water
3. Determination of the melting points of given organic compounds and unknown organic compounds (using Kjeldahl method and electrically heated melting point apparatus).
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds.
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
6. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography

Recommended Books/Reference:

1. F. G. Mann, B. C. Saunders, *Practical Organic Chemistry,* Pearson Education (2009)
2. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)

COURSE OUTCOMES

- Ensures the students to understand acquire knowledge and analysis by using physiochemical techniques.
- Purification of organic compounds.
- Separation of a mixture of two amino acids using paper-chromatograhy.

Subject II
Minor
Semester – II
Algebra and Geometry

Course Learning Outcomes
This course will enable the students to:

- Understand the importance of roots of real and complex polynomials and learn various methods of obtaining roots.
- Familiarize with relations, equivalence relations and partitions.
- Employ De Moivre's theorem in a number of applications to solve numerical problems.
- Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
- Find eigenvalues and corresponding eigenvectors for a square matrix.
- Explain the properties of three dimensional shapes.

Unit-I: Theory of Equations and Complex Numbers
Elementary theorems on the roots of an equations including Cardan's method, The remainder and factor theorems, Synthetic division, Factored form of a polynomial, The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Imaginary roots, Integral and rational roots; Polar representation of complex numbers, The *n*th roots of unity, De Moivre's theorem for integer and rational indices and its applications.

Unit-II: Relations and Basic Number Theory
Relations, Equivalence relations, Equivalence classes; Functions, Composition of functions, Inverse of a function; Finite, countable and uncountable sets; The division algorithm, Divisibility and the Euclidean algorithm, The fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences; Principles of mathematical induction and well ordering.

Unit-III: Row Echelon Form of Matrices and Applications
Systems of linear equations, Row reduction and echelon forms, Linear independence, The rank of a matrix and applications; Introduction to linear transformations, The matrix of a linear transformation, Matrix operations, Determinants, The inverse of a matrix, Characterizations of invertible matrices; Applications to Computer Graphics; Eigenvalues and eigenvectors, The characteristic equation and the Cayley Hamilton theorem.

Unit-IV: Planes, Straight Lines and Spheres
Planes: Distance of a point from a plane, Angle between two planes, pair of planes, Bisectors of angles between two planes; Straight lines: Equations of straight lines, Distance of a point from a straight line, Distance between two straight lines, Distance between a straight line and a plane; Spheres: Different forms, Intersection of two spheres, Orthogonal intersection, Tangents and normal, Radical plane, Radical line, Coaxial system of spheres, Pole, Polar and Conjugacy.

Unit-V: Locus, Surfaces, Curves and Conicoids

Space curves, Algebraic curves, Ruled surfaces, Some standard surfaces, Classification of quadric surfaces, Cone, Cylinder, Central conicoids, Tangent plane, Normal, Polar planes, and Polar lines.

References

1. Titu Andreescu, & Dorin Andrica (2014). *Complex Numbers from A to...Z*. (2nd edition). Birkhäuser.
2. Robert J. T. Bell (1994). *An Elementary Treatise on Coordinate Geometry of Three Dimensions*. Macmillan India Ltd.
3. D. Chatterjee (2009). *Analytical Geometry: Two and Three Dimensions*. Narosa Publishing House.
4. Leonard Eugene Dickson (2009). *First Course in the Theory of Equations*. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785)
5. Edgar G. Goodaire & Michael M. Parmenter (2015). *Discrete Mathematics with Graph Theory* (3rd edition). Pearson Education Pvt. Ltd. India.
6. Bernard Kolman & David R. Hill (2003). *Introductory Linear Algebra with Applications* (7th edition). Pearson Education Pvt. Ltd. India.
7. David C. Lay, Steven R. Lay & Judi J. McDonald (2016). *Linear Algebra and its Applications* (5th edition). Pearson Education Pvt. Ltd. India.

COURSE OUTCOMES

The students will be able to

- Know the complex members to understanding the basic number theory.
- To get knowledge about matrices, planes, straight line etc.
- To understand locus, surfaces, curves and conicoids.

Subject II
Minor
Semester – II
Minor

Course Objective

- Students will learn about cell theory and techniques for fractionation of sub-cellular organelles.
- They will be acquainted to various microscopic techniques to visualize subcellular organelles.
- Students will have an understanding of the composition of cytoskeleton and extracellular matrix.
- Students will acquire knowledge of cell cycle, cell division and cell death mechanisms.

Course Content:

Unit-I: Introduction of Cell
Origin of life, Cell theory, Structure of prokaryotic and eukaryotic cell. Differences in Animal and Plant cell. Mycoplasma, viruses, viroids, prions.

Unit-II: Structure and function of subcellular organelles
Composition ofbiological membranes. Nucleus: Structure of nuclear envelope, nuclear pore complex nucleolus and chromatin. Endoplasmic Reticulum: RER - Brief overview of co-translational and post-translational transport of proteins; SER – Lipid synthesis, brief overview of export of proteins from ER; Golgi apparatus: organization, brief overview of glycosylation of proteins within Golgi, lipid and polysaccharide metabolism in Golgi apparatus.

Unit-III: Cell Fractionation techniques
Centrifugation, Sedimentation Coefficient, Differential and Density Gradient (isopycnic and rate zonal) centrifugation. Cell Visualization techniques: Principle of Light microscope, Phase Contrast microscope, Fluorescence microscope, Confocal microscope and Electron microscope; Staining techniques for microscopy studies. Principles of identification of sub cellular organelles.

Unit-IV: Lysosomes
Different forms of lysosomes, role in cellular digestion, lysosomal storage diseases.
Peroxisomes: assembly, functions, glyoxysomes.
Mitochondria: structure, endosymbiont theory, genome,
Chloroplast: Structure, function, organization

Cell Wall: Structure of prokaryotic and eukaryotic cell wall; ECM components– proteins, polysaccharides and adhesion proteins; concept of anchoring junctions, tight junctions and communication junctions (gap junctions and plasmodesmata).

Cytoskeleton. Microtubules: Axonemal and cytoplasmic microtubules (cilia, flagella, centrioles, basal bodies). Microfilaments: Actin and Myosin Filaments. Role of cytoskeletal elements in the entry of infectious agents

Unit-V: Cell Cycle and Cell Division
(mitosis and meiosis); Apoptosis and necrosis; Types and potency of Stem Cells, Cancer-types, salient features of a transformed cell, causes of cancer. Apoptotic death in relation to cell cycle.

Recommended Books/References:

1. The Cell: A Molecular Approach (2013) 6th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0- 87893-300- 6.
2. Cell and Molecular Biology: Concepts and Experiments. (2010). Karp, G., 6th ed. John Wiley and Sons. Inc. ISBN: 978-1-118-65322-7
3. Principles and Techniques of Biochemistry and Molecular Biology: - Ed. K. Wilson and J. Walker, Cambridge University Press.
4. Physical Biochemistry- Application to Biochemistry and Molecular Biology: Friefelder D. WH Freeman and Company.
5. Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson, D.L. and Cox, M.M.
6. W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10- 1464126119.
7. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York), ISBN:0-321-50781 / ISBN: 978-0-321-50781-5.

Course Outcomes

- This course will provide an understanding of the structure of cell and function of various sub cellular organelles.
- Students will learn about cell theory, basic cell structure, cell fractionation and cell visualization techniques. Besides, students will have an understanding of the composition of cytoskeleton and extracellular matrix.
- Students will acquire knowledge of cell cycle, cell division and cell death mechanisms.

Semester-II
Practical
Cell Biology

Course objectives

- Students will learn the handling of microscope.
- Obtain hands-on training in basic separation techniques in biochemistry
- Gain expertise in the isolation of various cell organelles and staining of cellular biomolecules.

Course Content:

1. To study different parts of microscope
2. Cytochemical staining of proteins by Methylene blue
3. Cytochemical staining of polysaccharides by PAS
4. Cytochemical staining of RNA by Methyl Green
5. Study of stages of Mitosis
6. Study of stages of Meiosis
7. To study cell organelles
8. To study the effect of isotonic, hypotonic and hypertonic solutions on cells

Course outcomes:

- Students will learn the handling of microscope.
- They will gain knowledge about the structure and function of various cell organelles.
- The students will obtain hands-on training in basic separation techniques in biochemistry and gain expertise in the isolation of various cell organelles and staining of cellular biomolecules.

Subject III
GEC
Semester – II
Life Science/Biology-I

COURSE OBJECTIVES

The Chemistry involved in biological processes is need of the time. Therefore, the main objective of the course is to know the basics of the biology which are generally applied in chemistry. The students will be able to understand the biological process through the course.

Unit-I: Cell and Cellular Processes

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components

Unit-II: Cell Organelles

Mitochondria: Structure, marker enzymes, composition; mitochondrial biogenesis; Semiautonomous organelle; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA

Chloroplast: Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA

ER, Golgi body & Lysosomes: Structures and roles. Signal peptide hypothesis, N-linked glycosylation, Role of golgi in O-linked glycosylation. Cell secretion, Lysosome formation.

Peroxisomes and Glyoxisomes: Structures, composition, functions in animals and plants and biogenesis.

Unit-III: Nucleus

Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall

Unit-IV: Cell Cycle

Role of Cell division; Overview of Cell cycle; Molecular controls; Meiosis Interphase, Mitosis and Meiosis.

Unit-V: Instrumentation techniques

Principles of microscopy; Light Microscope; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Introduction to Electron microscopy (EM)- Scanning EM and sample analysis with examples.

Recommended books/References

1. Campbell, N.A. and Reece, J. B. Biology (Eighth edition) Pearson Benjamin Cummings, San Francisco, (2008).
2. Raven, P.H *et al* Biology, Seventh edition Tata McGraw Hill, New Delhi (2006).
3. Sheeler, P and Bianchi, D.E. Cell and Molecular Biology (Third edition) John Wiley (2006)

COURSE OUTCOMES

Basic knowledge of biology is also involved in chemistry related to real life problems which chemistry students must know. The students coming from Mathematics background are made aware o the basic knowledge required. Hence, the course is useful in understanding topics covered in this course.

Semester – II
Practical for Biology

1. Study of prokaryotic cells (bacteria), viruses, eukaryotic cells using microscope.
2. Study of the photomicrographs of cell organelles
3. To study the structure of plant cell through temporary mounts.
4. To study the structure of animal cells by temporary mounts-squamous epithelial cell and nerve cell.
5. Preparation of temporary mounts of striated muscle fiber
6. To prepare temporary stained preparation of mitochondria from striated muscle cells/ cheek epithelial cells using vital stain Janus green.
7. To prepare temporary stained squash from root tips of *Allium cepa* and to study the various stages of mitosis.
8. Study the effect of temperature, organic solvent on semi permeable membrane.
9. Demonstration of dialysis of starch and simple sugar.
10. Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.
11. Measure the cell size (either length or breadth/diameter) by micrometry.
12. Study the structure of nuclear pore complex by photograph (from Gerald Karp)

COURSE OUTCOMES
The students will be able to

- Estimate the qualitative physiological functional measurement according to their structure.
- Separate and isolated by the fraction preparation of cellular components from any cellular /organ based samples.
- Student know the knowledge and handling with standard protocols and modern instrumentation related to cell and organelles etc.

Subject I
Major
Semester III
301: Physical Chemistry-I

COURSE OBJECTIVE

This course will enable the students to

1. Familiarization with various states of matter.
2. Physical properties of each state of matter and laws related to describe the states.
3. Calculation of lattice parameters.
4. Electrolytes and electrolytic dissociation, salt hydrolysis and acid-base equilibria.
5. Understanding Kinetic model of gas and its properties.
6. Maxwell distribution, mean-free path, kinetic energies.
7. Behavior of real gases, its deviation from ideal behavior, equation of state, isotherm, and law of corresponding states.
8. Liquid state and its physical properties related to temperature and pressure variation.
9. Properties of liquid as solvent for various household and commercial use.
10. Solids, lattice parameters – its calculation, application of symmetry, solid characteristics of simple salts.
11. Ionic equilibria – electrolyte, ionization, dissociation.
12. Salt hydrolysis (acid-base hydrolysis) and its application in chemistry.

Unit-I: Behavior of real gases

Deviations from ideal gas behavior, compressibility factor, and its variation with pressure for different gases. Causes of deviation from ideal behavior. van der Waals equation of state, its derivation and application in explaining real gas behaviour; van der Waals equation expressed in virial form, Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, critical and van der Waals constants, law of corresponding states.

Unit-II: Chemical Kinetics

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Unit-III: Liquid State

Structure and physical properties of liquids; vapour pressure, surface tension, viscosity, and their dependence on temperature, Effect of addition of various solutes on surface tension, cleansing action of detergents. Structure of water.

Unit-IV: Ionic equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di- and tri-protic acids. Salt hydrolysis, hydrolysis constants, degree of hydrolysis and pH for different salts. Buffer solutions; Henderson equation, buffer capacity, buffer range, buffer action, applications of buffers in analytical chemistry, Solubility and solubility product. Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolytes.

Unit-IV: Solid state

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Various types of defects in crystals, Glasses and liquid crystals.

References

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press (2006). 2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
5 G. M. Barrow, Tata McGraw Hill (Fifth Edition) (2007

COURSE OUTCOMES

On completion of this course, the students will be able to understand:

- Familiarization with various states of matter.
- Physical properties of each state of matter and laws related to describe the states.
- Calculation of lattice parameters.
- Electrolytes and electrolytic dissociation, salt hydrolysis and acid-base equilibria.
- Understanding Kinetic model of gas and its properties.
- Maxwell distribution, mean-free path, kinetic energies.
- Behavior of real gases, its deviation from ideal behavior, equation of state, isotherm, and law of corresponding states.
- Liquid state and its physical properties related to temperature and pressure variation.
- Properties of liquid as solvent for various household and commercial use.
- Solids, lattice parameters – its calculation, application of symmetry, solid characteristics of simple salts.
- Ionic equilibria – electrolyte, ionization, dissociation.
- Salt hydrolysis (acid-base hydrolysis) and its application in chemistry.

Semester III
Practical
301: Physical Chemistry

COURSE OBJECTIVE

This course will enable the students to:

- The determine the surface tension.
- pH metric experiments.

Course content

1. Surface tension measurements.

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension of detergent solutions with concentration.

2. Viscosity measurements using Ostwald's viscometer.

a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol (iii) sugar at room temperature.

b. Viscosity of sucrose solution with the concentration of solute.

3. pH metry

a. Effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.

b. Preparation of buffer solutions of different pH

i. Sodium acetate-acetic acid

ii. Ammonium chloride-ammonium hydroxide

c. pH metric titration of

(i) Strong acid vs. strong base

(ii) Weak acid vs. strong base.

d. Determination of dissociation constant of a weak acid.

References

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).

3. Halpern, A. M. &McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

4. Athawale V. D. and Mathur P. Experimental Physical Chemistry, New Age International (2001).

COURSE OUTCOMES

On completion of this course, the students will be able to understand:

- Determine the surface tension of liquids.
- To understand the different pH metric experiments.

Subject II
Minor
Semester III
302: Partial Differential Equations and Calculus of Variations

Course Learning Outcomes

This course will enable the students to:

- Apply a range of techniques to solve first & second order partial differential equations
- Model physical phenomena using partial differential equations such as the heat and wave equations.
- Understand problems, methods and techniques of calculus of variations.

Unit-I: First Order Partial Differential Equations

Order and degree of Partial differential equations (PDE), Concept of linear and non-linear partial differential equations, Partial differential equations of the first order, Lagrange's method, Some special type of equation which can be solved easily by methods other than the general method, Charpit's general method.

Unit-II: Second Order Partial Differential Equations with Constant Coefficients

Classification of linear partial differential equations of second order, Homogeneous and non-homogeneous equations with constant coefficients.

Unit-III: Second Order Partial Differential Equations with Variable Coefficients

Partial differential equations reducible to equations with constant coefficient, Second order PDE with variable coefficients, Classification of second order PDE, Reduction to canonical or normal form; Monge's method; Solution of heat and wave equations in one and two dimensions by method of separation of variables.

Unit-IV: Calculus of Variations-Variational Problems with Fixed Boundaries

Euler's equation for functional containing first order and higher order total derivatives, Functionals containing first order partial derivatives, Variational problems in parametric form, Invariance of Euler's equation under coordinates transformation.

Unit-V: Calculus of Variations-Variational Problems with Moving Boundaries

Variational problems with moving boundaries, Functionals dependent on one and two variables, One sided variation. Sufficient conditions for an extremum-Jacobi and Legendre conditions, Second variation.

References

1. A. S. Gupta (2004). Calculus of Variations with Applications. PHI Learning.
2. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.
3. TynMyint-U &Lokenath Debnath (2013). Linear Partial Differential Equation for Scientists and Engineers (4th edition). Springer India.
4. H. T. H. Piaggio (2004). An Elementary Treatise on Differential Equations and Their Applications. CBS Publishers.
5. S. B. Rao & H. R. Anuradha (1996). Differential Equations with Applications. University Press. 6. Ian N. Sneddon (2006). Elements of Partial Differential Equations. Dover Publications.

COURSE OUTCOMES

The students will be able to

- To understand first order and second order Partial Differential Equations.
- To learn the Calculus of Variations and Variational Problems with Fixed Boundaries.

Subject II
Minor
Semester III
302: Human Physiology

COURSE OBJECTIVE

Students will gain insights into the mechanism of signal transduction by steroid and polypeptide hormones and the role of second messengers in signal transduction. The process of gaseous exchange in tissues and lungs, respiratory adaption to high altitude and the difference between hemoglobin and myoglobin will be explained. Students will gain awareness on muscular dystrophies, the role of steroids in muscle building and the use of hormones in cattle and poultry industry. Role of kidney in erythropoiesis will be explained.

Unit-I: Nervous System

(a) **Neurotransmission:** Types of neurons, generalized structure of multipolar neuron. Resting membrane potential, Action potential, Transmission of nerve impulse along an axon and across a synapse. Neurotransmitters and inhibitors of neurotransmission.
(b)**Muscle:**Types of muscles and their structure. Ultra-structure of skeletal muscle. Contractile and regulatory proteins of muscle. Sliding filament model of skeletal muscle contraction.

Unit-II: Excretory system

Excretory system: Physiology and anatomy of kidney, Structure of the nephron, Types of nephron, urea cycle, formation of urine - Glomerular filtration, tubular reabsorption and secretions.

Unit-III: Body Fluids

Blood volume, composition and functions, RBC, WBC and platelets, their structure and functions. Mechanism of blood coagulation. Biochemical events in transport of CO_2 and O_2 in blood. Cerebrospinal fluid, lymph and its function. Blood brain barrier.

Acid-base balance: Maintenance of normal pH of the body fluids. Blood buffers. Role of lungs and kidney in acid base balance.

Unit-IV: Endocrine system

Endocrine system: Endocrine organs, classification of hormones. Regulation of hormone secretions. Functions of the hormones of hypothalamus, pituitary, adrenal, thyroid, pancreas and gonads. General mechanism of steroid hormone action. Mechanism of hormone action.

Unit-V: Digestive System

GIT and Liver: Structure and function of gastrointestinal tract, Structure of a lobule, Digestion and absorption of food, detoxification.

References

1. Human Physiology, Vol. I & II, - C. C. Chatterjee -Medical Allied Agency-Calcutta.
2. Concise Medical Physiology – Choudhary – New Central Book Agency- Calcutta.
3. Text Book of Medical Physiology – Guyton – Prism Books Pvt. Ltd.- Bangalore.
4. Harper's Biochemistry – Murray, Granner, Mayes, and Rodwell -Prentice Hall International Inc.
5. Textbook of medical physiology: A. C. Gyton, and J. E HallSaunders Elsevier Publications, A division of Reed Elsevier India Pvt. Ltd. New Delhi ISBN 81-8147-084-2.
6. Human physiology: Chatterjee, Medical Allied Agency.

COURSE OUTCOMES

The students will be able to:

- To understand various human Systems like nervous system, digestive system, excretory system etc.
- They will also understand body fluids.

Semester III
Practical
302: Human Physiology

COURSE OBJECTIVES

The student will learn

1. The basics of Human Physiology practicals.
2. Students will obtain hands on training on given exercises.

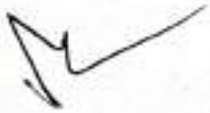
Course Content

1. Preparation of blood smear and differential leucocyte count.
2. RBC and WBC counting, Calculation of blood Indices.
3. Estimation of hemoglobin
4. Colorimetric estimation of Protein by Lowry's method.
5. Estimation of Uric acid.
6. Urea by DAMO method.
7. Creatinine by Jaffe's method.
8. Phosphorous by Fiske and Subbarow's method.
9. Iron by Wong's method.
10. Qualitative analysis of urine - detection of urea, uric acid and creatinine.

COURSE OUTCOMES

The student will learn the handling of different used apparatus.

- Student will learn the knowledge of different physiology experiments.
- Students will obtain hand-on training in the modern protocols basic of bio-analytical techniques.



Subject III
GE-III
Semester III
303: Fundamentals of Computers

COURSE OBJECTIVES

The computer fundamentals involved in various principles is need of time. Therefore, the main objective of the course is to know the basics of the fundamentals of computers which are generally applied in computer fundamentals.

Unit-1: Introduction

Introduction to computer system, uses, types of computers, generations of computer.

Computer Organisation and Architecture: C.P.U., registers, system bus, main memory unit.

Unit-2: Devices

Input and output devices (with connections and practical demo), keyboard, mouse, joystick, scanner, OCR, OMR, bar code reader, web camera, monitor, printer, plotter etc.

Memory: Primary, secondary, auxiliary memory, RAM, ROM, cache memory, hard disks, optical disks.

Unit-3: Human Computer Interface

Types of software, Operating system as user interface, utility programs. MS-Office: Basics of MS-Word, MS-Excel and MS-PowerPoint.

Unit- 4: Computer Networks

Overview of Computer Network, Types of computer networks (LAN, WAN, MAN), Components of computer networks (Servers, workstations, network interface cards, hub, switches, cables etc.)

Unit - 5: Internet

Overview of Internet, www, IP address, URL, web pages, web browsers, Internet, Protocols, Search engines, e-mail, downloading and uploading from internet. Overview of Emerging

Technologies: Bluetooth, cloud computing, data mining, mobile computing.

References

1. P. K. Sinha, P. Sinha, Fundamentals of Computers, BPB Publishers, 2007.
2. B. Ram, Sanjay Kumar, Computer Fundamentals: Architecture and Organization, New Age International Publishers.
3. A. Goel, Computer Fundamentals, Pearson Education, 2010.
4. P. Aksoy, L. De Nardis, Introduction to Information Technology, Cengage Learning, 2006.

COURSE OUTCOMES

The basic knowledge of computer fundamentals is also involved in chemistry related to different topics of chemistry. Hence course is useful in understanding the topics covered in proposed course.

Subject IV
SE-I
Semester III
304: Biofertilizers

COURSE OBJECTIVE

On the completion of this course, the students will be able to

- Develop their understanding on the concept of bio-fertilizer
- Identify the different forms of biofertilizers and their uses
- Compare between the Green manuring and organic fertilizers
- Develop the integrated management for better crop production by using both nitrogenous and phosphate bio fertilizers and vesicular arbuscular mycorrhizal (VAM).
- Interpret and explain the components, patterns, and processes of bacteria for growth in crop production

Unit I: Microbes as fertilizers

General account about the microbes used as biofertilizer-Rhizobium – isolation, identification, inoculum production and field application, legume/pulses plants. carrier based inoculants, Actinorrhizal symbiosis.

Unit II: Azospirillum and Azotobacter

Azospirillum: Isolation and mass multiplication-carrier-based inoculant, associative effect of different microorganisms.

Azotobacter: Classification, characteristics-crop response to Azotobacter inoculum, maintenance and mass multiplication.

Unit III: Blue green algae, Phosphate solubilising microbes

Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation. Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application.

Unit IV: Mycorrhizal effect on plant growth

General account of Mycorrhizae; Types of mycorrhizae: ectomycorrhizae and endomycorrhizae; Types of associations, occurrence and distribution, Nutrition, growth and yield – colonization of vesicular-arbuscular mycorrhiza (VAM)– isolation and inoculums; production of VAM and its influence on growth and yield of crop plants.

Unit V: Microbial use in bioinsecticides and biocompost

Microbes used as bioinsecticides and their merits over synthetic pesticides, Bacillus thuringiensis, production and Field application. Viruses – cultivation and field applications. Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable wastes: municipal, agricultural and Industrial wastes. Methods of making biocompost; Procedure of vermicomposting and field application.

References

1. Dubey, R.C. (2005). A Text book of Biotechnology S. Chand& Co, New Delhi.
2. John Jothi Prakash, E. (2004). Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
3. Kumaresan, V. (2005). Biotechnology, Saras Publications, New Delhi.
4. NIIR Board. (2012). The complete Technology Book on Biofertilizer and organic farming. 2nd Edition. NIIR Project Consultancy Services.
5. Sathe, T.V. (2004) Vermiculture and Organic Farming. Daya publishers.
6. Subba Rao, N.S. (2017). Biofertilizers in Agriculture and Forestry. Fourth Edition. Medtech.
7. Vayas, S.C.; Vayas, S. and Modi, H.A. (1998). Bio-fertilizers and organic Farming AktaPrakashan, Nadiad

COURSE OUTCOMES

The students will be able to

- Develop their understanding on the concept of bio-fertilizer
- Identify the different forms of biofertilizers and their uses
- Compare between the Green manuring and organic fertilizers
- Develop the integrated management for better crop production by using both nitrogenous and phosphate bio fertilizers and vesicular arbuscular mycorrhizal (VAM).
- Interpret and explain the components, patterns, and processes of bacteria for growth in crop prod

Subject I
Major
Semester IV
401: Organic Chemistry-II

COURSE OBJECTIVE

After completion of the course, the learner shall be able to understand

- Familiarization about classes of organic compounds and their methods of preparation.
- Basic uses of reaction mechanisms.
- Name reactions, uses of various reagents and the mechanism of their action.
- Preparation and uses of various classes of organic compounds.
- Organometallic compounds and their uses.
- Organic chemistry reactions and reaction mechanisms.
- Use of reagents in various organic transformation reactions.
- Chemistry of halogenated hydrocarbons.

Unit-I: Alkyl halides

Methods of preparation, nucleophilic substitution reactions – SN^1, SN^2 and SNi mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Unit-II: Aryl halides

Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg and Li and their use in synthesis.

Unit-III: Alcohols, Phenols, Ethers and Epoxides

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement. Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism. Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and LiAlH4.

Unit-IV: Carbonyl Compounds

Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC and PGC); Addition reactions of unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Unit-V: Carboxylic Acids and their Derivatives

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids; Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmannbromamide degradation and Curtius rearrangement.

References

1. Solomons, T.W G., Fryhle, B. Craig. Organic Chemistry, John Wiley & Sons, Inc (2009).
2. McMurry, J.E. Fundamentals of Organic Chemistry, Seventh edition Cengage Learning, 2013.
3. P Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman, and New Delhi.
4. Morrison R. T. and Boyd R. N. Organic Chemistry, Sixth Edition Prentice Hall India, 2003.

COURSE OUTCOMES

The learner shall be able to understand

- Familiarization about classes of organic compounds and their methods of preparation.
- Basic uses of reaction mechanisms.
- Name reactions, uses of varjous reagents and the mechanism of their action.
- Preparation and uses of various classes of organic compounds etc.

Semester IV
Practical
401: Organic Chemistry

COURSE OBJECTIVE

After completion of the course, the learner shall be able to understand

- Functional groups determination of organic compounds.
- Organic preparations of different organic compounds.

Course content

1. Functional group tests for alcohols, phenols, carbonyl, carboxylic acid and amine group of compounds.

2. Organic preparations:

i.) Acetylation of one of the following compounds: amines (aniline, o-, m-, p-toluidines and o-, m-, p-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method: (Using conventional method.and Using green chemistry approach)

ii.) Benzolyation of one of the amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and one of the phenols (β-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction.

iii.) Oxidation of ethanol/ isopropanol (Iodoform reaction).

iv.) Bromination (any one) a. Acetanilide by conventional methods b. Acetanilide using green approach (Bromate-bromide method)

v.) Nitration: (any one) a. Acetanilide/nitrobenzene by conventional method b. Salicylic acid by green approach (using ceric ammonium nitrate).

vi.) Selective reduction of meta dinitrobenzene to m-nitroaniline.

vii.) Reduction of p-nitrobenzaldehyde by sodium borohydride.

viii.) Hydrolysis of amides and esters.

ix.) Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.

x.) S-Benzylisothiouronium salt of one each of water soluble/ insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).

xi.) Aldol condensation with either conventional or green method.

xii.) Benzil-Benzilic acid rearrangement. Collected solid samples may be used for recrystallization, melting point and TLC.

References

1 Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

2 Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical Organic Chemistry, 5th Ed. Pearson (2012)

3 Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000)

4 Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

COURSE OUTCOMES

The student will be able to

- Identification of functional groups.
- Synthesis of different organic compounds.

Subject II
Minor
Semester IV
402: Probability and Statistics

COURSE OBJECTIVE

This course will enable the students to

- Understand the basic concepts of probability.
- Appreciate the importance of probability distribution of random variables and to know the notion of central tendency.
- Establish the joint distribution of two random variables in terms their correlation and regression.
- Understand central limit theorem which shows that the empirical frequencies of so many natural populations exhibit normal distribution.
- Study entropy and information theory in the framework of probabilistic models.

Unit-I: Probability and Random Variables

Axiomatic and empirical definitions of probability, Independent and dependent events, Conditional probability and Baye's theorem; Discrete and continuous random variables and their probability distributions, Cumulative distribution function, *n*th Moments, Moment generating function, Characteristic function.

Unit-II: Univariate Distributions

Discrete distributions: Bernoulli trials and Bernoulli distribution, Binomial and Poisson distributions;
Continuous distributions: Uniform, Geometric, Gamma, Exponential, Chisquare, Beta and normal distributions; Normal approximation to the binomial distribution, Central limit theorem.

Unit-III: Bivariate Distribution

Joint cumulative distribution function and its properties, Joint probability density function, Margina distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations, Independence of bivariate random variables.

Unit-IV: Correlation and Regression

The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Markov theorem, Chebyshev's theorem, Weak and strong law of large numbers.

Unit-V: Information Theory

Uncertainty, Information and entropy, Conditional and joint entropy, Uniform Priors, Polya'surn model and random graphs, Applications of random graphs.

References

1. David Applebaum (1996). *Probability and Information: An Integrated Approach.* Cambridge University Press.
2. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). *Introduction to Mathematical Statistics* (7th edition), Pearson Education.
3. Irwin Miller & Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8th edition). Pearson. Dorling Kindersley Pvt. Ltd. India.
4. Jim Pitman (1993). *Probability*, Springer-Verlag.
5. Sheldon M. Ross (2014). *Introduction to Probability Models* (11th edition). Elsevier.
6. A. M. Yaglom and I. M. Yaglom (1983). *Probability and Information*. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

COURSE OUTCOMES

The students will be able to

- Understand the basic concepts of probability.
- Appreciate the importance of probability distribution of random variables and to know the notion of central tendency.
- Establish the joint distribution of two random variables in terms their correlation and regression etc..

Subject II
Minor
Semester IV
402: Biochemistry of Enzymes

COURSE OBJECTIVE

This course will provide fundamental knowledge on enzymes and their importance in biological reactions. Students will understand the difference between a chemical catalyst and biocatalyst and understand activation energy. They will study non-protein enzymes such as ribozymes and will be exposed to the Industrial and biomedical applications of enzymes.

Unit –1: Enzymes and its Classification

Enzymes: Definition, general characteristics, co-factors – coenzymes and metal ions. **Classification of enzymes**: Based on IUB with examples. Unit of enzyme activity – definition of IU, enzyme turn over number. Enzyme specificity. Concept of active site, ES complex.

Theories of enzyme catalysis: Lock and key model, Koshland's induced fit theory. Factors affecting rate of enzyme catalyzed reactions.

Unit-2: Characterization of enzymes

Characterization: Effect of enzyme concentration, substrate concentration, pH and temperature. Michaelis – Menten equation, Lineweaver – Burk(L-B) plot. Determination of V_{max} & K_m from L-B plot and their significance, Enzyme inhibition–competitive, noncompetitive and uncompetitive.

Unit – 3: Mechanism and Allosteric enzymes

Chemical modificationof active site groups. Site directed mutagenesis of enzymes. Mechanism of action of chymotrypsin.

Allosteric enzymes: Sigmoidal curve, positive and negative modulators. Mechanism of "concerted" & "sequential" models for allosteric enzymes. Flipflop mechanism, positive and negative co-operativity with special reference to aspartate transcarbamylase and phosphofructokinase.

Unit – 4: Isoenzymes

Nature of Lactate dehydrogenase. Multi-enzyme complex – Pyruvate dehydrogenase complex. – Composition, subunits, assembly. Enzymatic reaction & functions of RNA as an enzyme. (Ribozymes). Industrial and medical application of enzymes.

Unit – 5: Applications of Enzymes

Enzymes as reagents, Marker enzymes in diagnostics, Immobilizedenzymes, Industrial applications of enzymes.

Reference

1. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford.

COURSE OUTCOMES

This course will enable the students to:

- Understand the basic concepts of enzymes.
- Appreciate the importance of enzymes and to know the applications of enzymes.
- Students will learn mechanism of enzymes.

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Semester IV
Practical
402: Biochemistry of Enzymes

COURSE OBJECTIVE

The students will learn

- Isolation and demonstration of urease and acid phosphatase.
- Purification of urease.
- Determination of different biochemical parameters.

Course contents

1. Isolation of urease and demonstration of its activity.
2. Isolation of and demonstration of phosphatase its activity
3. Determination of specific activity of salivary amylase by DNS.
4. Purification of urease.
5. Time course of urease reaction.
6. Influence of substrate concentration and pH on the rate of enzymatic reaction.
7. Determination of K_m and V_{max} of salivary amylase.
8. Determination of initial velocity [time kinetics] of salivary amylase.
9. Determination of optimum temperature of salivary amylase.

Reference

1. Practical Biochemistry (Second Edition) K. Geetha Damodaran.

COURSE OUTCOMES

This course will enable the students to:

- Understand the isolation of urease and demonstration of its activity.
- Isolation of and demonstration of phosphatase its activity.
- Students will learn determination of different biochemical parameters.

Subject III
GE-IV
Semester IV
403: Elements of Modern Physics

COURSE OBJECTIVES

The Physics involved in various principles is need of time. Therefore, the main objective of the course is to know the basics of the physics which are generally applied in Physics. The student will be able to understand the different principles through the course.

Unit – 1

Planck's quantum, Planck's constant and light as a collection of photons; Photoelectric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra.

Unit – 2

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.

Unit – 3

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy.

Unit – 4

Radioactivity: stability of nucleus; Law of radioactive decay; Mean life and half-life; α - decay; β - decay - energy released, spectrum and Pauli's prediction of neutrino; γ-ray emission.

Unit – 5

Fission and fusion - mass deficit, relativity and generation of energy; Fission – nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions.

References

1. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
2. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2009, PHI Learning
3. Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, 2003, McGraw Hill 4. Quantum Physics, Berkeley Physics, Vol.4. E.H. Wichman, 2008, Tata McGraw Hill Co.
5. Modern Physics, R.A. Serway, C.J. Moses, and C.A. Moyer, 2005, Cengage Learning
6. Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill

COURSE OUTCOMES

The basic knowledge of Physics is also involved in chemistry related to different topics of chemistry. The students coming from biology background are made aware of basic knowledge required. Hence course is useful in understanding the topics covered in proposed course.

Subject IV
SE-II
Semester IV
404: Environmental Impact Analysis

COURSE OBJECTIVE

After completing this course, the learner will be able to

- Have critical understanding of environmental impact
- Learn important steps of EIA process
- Interpret the environmental appraisal and procedures in India.

Unit I: Origin and Development

Purpose and aim, core values and principles, History of EIA development, Environmental Management Plan, Environmental Impact Statement, Scope of EIA in planning a Project and its implementation.

Unit II: EIA Process

Assessment process of Environmental Impact: Screening, Scoping, Baseline data, Impact Identification, Prediction, Evaluation and Mitigation, Appendices and Forms of Application, Techniques of Assessment-Cost-benefit Analysis, Matrices, Checklist, Overlays, EIA Document.

Unit III: Main participants in EIA Process

Roles of Project proponents and environmental consultants, Roles of the State Pollution Control Boards (PCBs) /Pollution Control Committee (PCCs), Impact Assessment Act (IAA). Public participation.

Unit IV: Environmental Appraisal and Procedures in India and EIA

Environmental Audit of different environmental resources, Risk Analysis, Strategic environmental assessment, ecological impact assessment: legislation. Impact on Environmental component: air, noise, water, land, biological, social and environmental factors.

Unit V: EIA notification September 2006 and amendments

Categorization of projects, Procedure for getting environmental clearance. Public participation in environmental decision-making process. Case studies on EIA for Industries and Infrastructure projects.

References

1. Kulkarni V and Ramachandra TV, (2006). Environmental Management, Capital Pub. Co. New Delhi. Petts, J. (2005) Handbook of Environmental Impact Assessment- Volume 1 and 2.
2. Blackwell Publishers, UK. 3. Glasson, J. Therivel, R. and Chadwick, (2006)
3. Introduction to Environmental Impact Assessment. Routledge, London.
4. Canter, W. L. (1995) Environmental Impact Assessment, McGraw-Hill Science/ Engineering/ Math, New York;
5. Morris, P. and Therivel, R. (1995) Methods of Environmental Impact Assessment, UCL Press, London;
6. Petts, J. (1999) (ed) Handbook of Environmental Impact Assessment, volume 1 and 2, Blackwell Science, Oxford; 7. Therivel, R. and Partidario, M.R. (1996) (eds) The Practice of Strategic Environmental Assessment, Earthscan, London;
8. Vanclay, F. and Bronstein, D.A. (1995) (eds) Environmental and Social Impact Assessment, Wiley & Sons, Chichester.

COURSE OUTCOMES

The learner will be able to

- Have critical understanding of environmental impact
- Learn important steps of EIA process
- Interpret the environmental appraisal and procedures in India.

Subject I
Major
Semester V
501: Physical Chemistry-II

COURSE OBJECTIVE

After completion of the course, the learner shall be able to understand

1. Laws of thermodynamics and concepts.
2. Partial molar quantities and its attributes.
3. Dilute solution and its properties.
4. Understanding the concept of system, variables, heat, work, and laws of thermodynamics.
5. Understanding the concept of heat of reactions and use of equations in calculations of bond energy, enthalpy, etc.
6. Understanding the concept of entropy; reversible, irreversible processes. Calculation of entropy using 3nd law of thermodynamics.
7. Understanding the application of thermodynamics: Joule Thompson effects, partial molar quantities.
8. Understanding theories/thermodynamics of dilute solutions.

Unit-I Introduction to thermodynamics

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Unit-II Thermochemistry

Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations), pressure on enthalpy of reactions.

Unit-III Second Law

Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third Law of thermodynamics: residual entropy, calculation of absolute entropy of molecules.

Unit-IV Free Energy Functions

Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Unit-V Partial molar quantities

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Dilute solutions: Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties: [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

References

1. Atkins P. and De Paula, J. Physical Chemistry Tenth Ed., OUP, 2014.
2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa, 2004.
3. Engel, T. and Reid, P. Physical Chemistry 3rd Ed., Prentice Hall, 2012.
4. McQuarrie, D. A. and Simon, J. D. Molecular Thermodynamics Viva Books, 2004.
5. Roy, B. N. Fundamentals of Classical and Statistical Thermodynamics Wiley, 2001
6. Commonly Asked Questions in Thermodynamics. CRC Press, 2011.
7. Levine, I.N. Physical Chemistry 6th Ed., Tata Mc Graw Hill, 2010.
8. Metz, C.R. 2000 solved problems in chemistry, Schaum Series, 2006.

Semester V
Practical
501: Physical Chemistry

COURSE OBJECTIVE

After completing this course, the learner will be able to

- Critical solution temperature
- Composition of the phenol-water system
- Study the equilibrium of a reaction
- Study the kinetics of Acid hydrolysis
- Study the kinetics of saponification

Course contents

1. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
2. Study the equilibrium of at least one of the following reactions by the distribution method:

(i) $I_2(aq) + I^- \rightarrow I_3^-(aq)$

(ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$

3. Study the kinetics of the following reactions.

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Saponification of ethyl acetate.

4. Verification of Freundlich and Langmuir isotherms for adsorption of acetic acid and selected organic dye(s) on activated charcoal.

References

1. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand, New Delhi, 2011.

2.Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry, Eighth Edition, McGraw-Hill (2003).

3. Halpern, A. M. and McBane, G. C. Experimental Physical Chemistry, Third Edition, W. H. Freeman (2003)

COURSE OUTCOMES

The learner will be able to

- Critical solution temperature
- Composition of the phenol-water system
- Study the equilibrium of a reaction
- Study the kinetics of Acid hydrolysis
- Study the kinetics of saponification

COUSE OUTCOMES

On completion of this course, the students will be able to understand:

- Laws of thermodynamics and concepts.
- Partial molar quantities and its attributes.
- Dilute solution and its properties.
- Understanding the concept of system, variables, heat, work, and laws of thermodynamics.
- Understanding the concept of heat of reactions and use of equations in calculations of bond energy, enthalpy, etc.
- Understanding the concept of entropy; reversible, irreversible processes. Calculation of entropy using 3rd law of thermodynamics.

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Subject II
DSE-I
Semester V
502: Polymer Chemistry

COURSE OBJECTIVE

After completion of the course, the learner can be able to understand:

- The mechanism of polymer material formation.
- Molecular weight and structure property relationship
- Polymerization procedure and Zigler-Natta catalysis.
- Characterization of polymers

Unit-I: Introduction

Polymer, monomer, examples of polymers, biopolymers, classification, polymerization process, degree of polymerization, condensation, addition polymers, kinetics of addition polymerization process.

Unit-II: Polymeric Structure and Property Relationship

Structure of polymers - Linear, branched, cross linked, and network polymers, molecular weight (number average, weight average, viscosity average) and distribution of molecular weight, polydispersity index, crystallinity in polymer, melting temperature and glass transition temperature, Volumetric properties - molar volume, density, Van der Waals volume - Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.

Unit-III: Polymerization Chemistry

Industrial methods of polymerization such as a bulk, solution, emulsion, suspension. Stereochemistry of polymers and stereo-specific polymerization, Catalysts-their utility in polymers and stereo-specific polymerizations, Catalysts their utility in polymer manufacture, Zieglar-Natta, Metallocene and others.

Unit-IV: Characterization of Polymers

Molecular Weight Determination by Light Scattering, Osmometry, End-Group Analysis, Viscosity, Gel Permeation Chromatography; Application, of FTIR, UV-visible, NMR, and Mass Spectroscopy for Identification of polymers.

Unit-V: Glass transition temperature (Tg) and determination of Tg

Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg). Polymer Solution – Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

References

1. D.W. Van Krevelen and P.J. Hoftyzen, "Properties of Polymer, 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork. 1990.
2. J.E. Mark Ed.AIP, Physical Properties of Polymers Hand Book, Williston, Vt, 1996.
3. Reaction Engineering of Step Growth Polymerization, S K Gupta and Anil Kumar, Plenum Press, 1987
4. Odian; George, Principles of Polymerization, McGraw-Hill Book Co., New York (1970).
5. W. Billmeyer, Text book of polymer science, 3rd Edn., 2007, Wiley.
6. J.R.Fried, Polymer Science and Technology, (2005), PHI publication.
7. Billmeyer Jr.; Fred W., Textbook of Polymer Science, Wiley- Interscience Publishers, New York (1962).

COURSE OUTCOMES

The learner can be able to understand

- The mechanism of polymer material formation.
- Molecular weight and structure property relationship
- Polymerization procedure and Zigler-Natta catalysis.
- Characterization of polymers

Subject II
DSE-I
Semester V
502: Advanced Analytical Chemistry

COURSE OBJECTIVE

After completion of the course, the learner can be able to understand

- Exposure with analytical techniques.
- To develop skills to handles different analytical Instruments.

Unit-I: Statistical methods in chemical analysis

Theory of error and treatment of quantitative data, accuracy and precision, ways of expressing accuracy and precision, Normal error curve and its equation. Useful statistical tests with equation, test of significance, the F-test, the students t-test, the Chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, regression analysis (least square method).

Unit-II: Polarography

Current-voltage relationship, theory of polarographic waves, instrumentation, qualitative and quantitative applications.

Unit-III: Thermal analysis

Theory, methodology, instruments and applications of theromogravimetric analysis (TGA/DTA), and differential scanning calorimetry (DSC).

Unit-IV: Chromatography

Principles of chromatography, paper, column and thin layer chromatography, Gas-liquid chromatography, HPLC.

Unit-V: Analysis of fuel and drugs

Fuel analysis: Solid, liquid and gaseous fuels, ultimate and proximate analysis of solid fuel, Determination of calorific value of solid, liquid and gaseous fuels, Flash point and fire point.

Drug analysis: Classification of drugs, Analysis of some standard drug using various chromatographic techniques.

References

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing California, USA, 1988. 3.Christian, G.D, Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.: Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
5. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis
6. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood John Wiley 1979.
7. Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.
8. Khopkar, S. M., Basic Concepts of Analytical Chemistry, New Age (Second edition) 1998

COURSE OBJECTIVE

The learner can be able to understand

- Exposure with analytical techniques.
- To develop skills to handles different analytical Instruments.

Subject III
SE-III
Semester V
503: Analytical Clinical Biochemistry

COURSE OBJECTIVE

After completion of the course, the learner can be able to understand

- Popularization with fundamentals of Analytical Clinical Biochemistry.
- Learning basics of different bio analytical techniques and their applications

Unit-I Carbohydrates:

Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysachharides.

Unit-II Proteins

Classification, biological importance; Primary and secondary and tertiary structures of proteins; α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins. Enzymes: Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

Unit-III Lipids:

Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. Lipoproteins: Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones.

Unit-IV Structure of DNA (Watson-Crick model) and RNA

Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy. Enzymes: Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition. A diagnostic approach to biochemistry:

Unit-V Blood

Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin. Urine: Collection and preservation of samples.

Formation of urine

Composition and estimation of constituents of normal and pathological urine.

References

1. Cooper, T.G. Tool of Biochemistry. Wiley-Blackwell (1977).
2. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009).
3. Varley, H., Gowenlock, A.H & Bell, M.: Practical Clinical Biochemistry, Heinemann, London (1980).
4. Devlin, T.M., Textbook of Biochemistry with Clinical Correlations, John Wiley & Sons, 2010.

COURSE OUTCOMES

- The proposed course will provide understandings of Analytical Clinical techniques.
- The students are made able to basic knowledge bio analytical techniques.

Subject I
Major
Semester VI
601: Molecular Spectroscopy and Photochemistry

COURSE OBJECTIVE

After completing this course, the learner will be able to:

- Electromagnetic radiation and Rotation spectroscopy
- Vibrational spectroscopy
- Raman spectroscopy
- Electronic spectroscopy
- Photophysical and photochemical processes

Unit-I: Electromagnetic radiation and Rotation spectroscopy

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Unit-II: Vibrational spectroscopy

Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Unit-III: Raman spectroscopy

Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Unit-IV: Electronic spectroscopy

Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation.

Unit-V: Photophysical and photochemical processes

laws of photochemistry, quantum yield. Jablonski diagrams: Franck-Condon principle, Law of photochemical equivalence, quantum efficiency, low and high quantum efficiency. kinetics of photochemical reactions ($H_2 + Br_2 = HBr$, $2HI = H_2 + I_2$), energy transfer in photochemical reactions (photosensitization and quenching), fluorescence, phosphorescence, chemiluminescence, Discussion of Electronic spectra and photochemistry (Lambert-Beer law and its applications).

References

1. Laideler K. J. and Meiser J. M. Physical Chemistry Third Edition (International)1999.
2. Levine I. N., Physical Chemistry, Fourth Edition), McGraw-Hill (International), 1995.
3. McQuarrie D. A. and Simon J. D. Physical Chemistry- A Molecular Approach, University Science Books, 1998.
4. Rohatgi-Mukherjee K. K. Fundamentals of Photochemistry, New age (revised second edition). 5. Banwell, C. N. &McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).

COURSE OUTCOMES

The learner will be able to:

- Electromagnetic radiation and Rotation spectroscopy
- Vibrational spectroscopy
- Raman spectroscopy
- Electronic spectroscopy
- Photophysical and photochemical processes

Semester VI
Practical
601: Molecular Spectroscopy and Photochemistry

COURSE OBJECTIVE

After completing this course, the learner will be able to

- Determination of indicator constant by colorimetry.
- Verification of Beer's Law by colorimetry

Course contents

(i). Determination of indicator constant - colorimetry.

(ii). Verification of Beer's Law - Determination of concentration of solution by colorimetry.

(iii). Interpretation of IR spectra.

(iv). Interpretation of Uv-visible spectra.

Reference

1. Practicals in physical chemistry – a modern approach, P.S.Sindhu, Macmillan,
2. Experiments in Physical Chemistry, J.M.Wilson, R.J.Newcomb, A.R.Denaro, 2nd Edn., Elsevier.

COURSE OUTCOMES

The learner will be able to

- Determination of indicator constant by colorimetry.
- Verification of Beer's Law by colorimetry

Subject II
DSE-II
Semester VI
602: Medicinal Chemistry

COURSE OBJECTIVE

After completion of the course, the learner can be able to understand

- The basics of medicinal chemistry, biophysical properties
- Biological activity parameters
- Drug metabolism
- Biophysical and chemical properties of enzymes, hormones, vitamins
- Concept of rational drug design

Unit-I: Bio-physicochemical properties

Acidity/Basicity, Solubility, Ionization, Hydrophobic properties, Hydrophilic properties, Lipinski Rule, Drug-like properties, Understanding of the biological activity parameters such as K_i, K_d, LD_{50}, EC_{50}, IC_{50}, CC_{50}, ADMET properties

Unit-II: Structural properties

Isosterism, Bioisosterism, Nonclassical isosteres, Understanding of the 3D-structure along with bond length, bond angle and dihydral angle, Concept of Configuration and Conformation with examples, Concept of stereochemistry in terms of biological response with examples, Stereoselective receptors or enzymes such as muscarinic receptor, Stereochemically pure drug and recemates, Examples such as catecholamines, etc.

Unit-III: Drug target understanding and Medicinal **Chemistry of Therapeutic Agent**

Metabolism, Drug metabolism, Anti-metabolite, Enzyme inhibitor, Agonist, Antagonist, Examples.Structure, Chemistry, Mode of action and adverse effect of the representative therapeutic agents such as Anti-infective agent, Antimalarials, Antibacterial, Antiviral, Anticancer, CNS acting drugs, Adrenergic Agents, Cholinergic Drugs, Diuretics, Cardivascular, local anesthetic agent, Analgesic Agents, Histamine and Antihistamine agents.

Unit-IV: Steroids, Prostaglandins, Enzyme, Hormone and Vitamins

Biophysico-chemical properties, Steroid Hormone Receptors, Chemical Contraceptive agents, COX-2 inhibitors, Prostaglandins for Ophthalmic use, pharmaceutically important enzyme products such as Pancreatin, Trypsin, Insulin. Classification of vitamins with examples.

Unit-V: Concept of rational drug design

Structure activity relationship, Drug-receptor understanding, Molecular modeling, Structure based drug design. QSAR.

References

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical ...by Charles Owens Wilson, John H. Block, Ole Gisvold, John Marlowe Beale
2. Foye's Principles of Medicinal Chemistry by David A. Williams, Thomas L. Lemke, William O. Foye (2008), Kluwer publication.
3. Remington: The Science and Practice of Pharmacy Vol 1, Ed. 19 by Joseph Price Remington, Alfonso R. Gennaro. (1995), MACK Publishing.
4. Burgers Medicinal Chemistry by Manfred E. Wolff, Alfred Burger
5. Burgers Medicinal Chemistry and Drug Discovery by Abraham D. J., Lewis F. L., Burger A., vol.5, 6th Edn., 2003, Hoboken N.J.Wiley,
6. The Organic Chemistry of Drug Design and Drug Action by Silverman R. B., 2nd Edn., Academic Press. 2012.

COURSE OUTCOMES

The learner can be able to understand

- The basics of medicinal chemistry, biophysical properties
- Biological activity parameters
- Drug metabolism
- Biophysical and chemical properties of enzymes, hormones, vitamins
- Concept of rational drug design

Subject II
DSE-II
Semester VI
602: Electrochemistry

COURSE OBJECTIVE

After completion of the course, the learner can be able to understand

- Basic principle of laws of electrochemistry.
- Understanding about chemical cells and their function
- Understanding about electrodes, EMF measurement.
- Understanding about potentiometric titrations and their applications.

Unit-I: Electrochemistry of weak and strong electrolytes-I

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules.

Unit-I: Electrochemistry of weak and strong electrolytes-II

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

Unit-III: Electrochemical laws of electrolysis

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen and quinone electrode.

Unit-IV: Electroanalytical methods

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

Unit-V: Electrical & Magnetic Properties of Atoms and Molecules

Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.

References

1.Atkins, P.W & Paula, J.D. Physical Chemistry, 10th Ed., Oxford University Press (2014).
2.Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3.Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
4.Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
5.Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
6.Rogers, D. W. Concise Physical Chemistry Wiley (2010).
7. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005).

COURSE OUTCOMES

The learner can be able to understand

- Basic principle of laws of electrochemistry.
- Understanding about chemical cells and their function
- Understanding about electrodes, EMF measurement.
- Understanding about potentiometric titrations and their applications.

Subject III
DSE-III
Semester VI
603: Organometallic and Bioinorganic Chemistry

COURSE OBJECTIVE

After completion of the course, the learner can be able to understand

- Chemistry of 3d Metals
- Organometallic Compounds
- Metal carbonyls
- Metal carbonyls
- Zeise's salt
- Ferrocene
- Bioinorganic chemistry

Unit-I: Chemistry of 3d Metals

Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties): Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

Unit-II: Organometallic Compounds

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands.

Unit-III: Metal carbonyls

18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. pi-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Unit-IV: Zeise's salt

Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds.

Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.

Unit-IV: Ferrocene

Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls.

Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies). Organometallic compounds of Mg and Li– Use in synthesis of organic compounds.

Unit-V: Bioinorganic chemistry

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

References

1. Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
2. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry Wiley-VCH, 1999.
3. Basolo, F, and Pearson, R.C. Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
4. Greenwood, N.N. & Earnshaw A. Chemistry of the Elements, Butterworth-Heinemann, 1997.

COURSE OBJECTIVE

The learner can be able to understand Chemistry of 3d Metals, Organometallic Compounds, Metal carbonyls, Metal carbonyls, Zeise's salt, Ferrocene and Bioinorganic chemistry.

Subject III
DSE-III
Semester VI
603: Organic Spectroscopy

COURSE OBJECTIVE

After completion of the course, the learner can be able to understand

- Basic Principles of UV Spectroscopy
- UV Spectroscopy
- Basic principles of IR Spectroscopy
- Basic Principles of UV Spectroscopy
- NMR (1H and 13C NMR)
- Basic principles Mass Spectrometry

Unit-I: Basic Principles of UV Spectroscopy

Application of Woodward-Fiser rule in interpretation of Organic compounds: Application of visible, ultraviolet and infrared spectroscopy in organic molecules.

Unit-II: UV Spectroscopy II

Electronic transitions, λmax & εmax, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λ max of conjugated dienes and α, β – unsaturated compounds.

Unit-III: Basic principles of IR Spectroscopy

Identification of Functional groups of various classes of organic compounds: Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

Unit-IV: NMR (1H and 13C NMR)

Application of Chemical Shifts, Splitting of signals, Spin coupling and Over Houser effect in interpretation of NMR spectra, Isotopic exchange.

Unit-V: Basic principles Mass Spectrometry

Application of fragmentation rule in characterization of organic compounds. Problems on structure elucidation of organic compounds based on spectral data.

References

1. R.M. Silverstein, G.C. Bassler & T.C. Morrill: Spectroscopic Identification of Organic Compounds, John Wiley & Sons.

2. John R. Dyer, Applications of absorption spectroscopy of organic compounds, Prentice Hall India (2012).

COURSE OBJECTIVE

The learner can be able to understand

- Basic Principles of UV Spectroscopy
- UV Spectroscopy
- Basic principles of IR Spectroscopy
- Basic Principles of UV Spectroscopy
- NMR (^{1}H and ^{13}C NMR)
- Basic principles Mass Spectrometry

Subject I
Major
Semester VII
701: Green Chemistry

COURSE OBJECTIVE

After completion of the course, the learner shall be able to understand:

- Green chemistry and its principles.
- Green synthesis and reactions.
- Green chemistry for sustainable solutions.
- Understanding principles of green chemistry.
- Understanding design of chemical reactions/chemical synthesis using green chemistry principles.
- Atom economy and design of chemical reactions using the principle.
- Understanding the use of green chemistry principle and processes in laboratory reactions.

Unit-I: Introduction to Green Chemistry

Basic introduction and explaining goals of Green Chemistry, Limitations/Obstacles in the pursuit of the goals of Green Chemistry

Unit-II: Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on Designing a Green Synthesis using these principles (Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions).

Unit-III: Green Synthesis / Reactions I

1.Green Synthesis of adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis).

2. Microwave assisted reactions in water: (Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols) and reactions in organic solvents (Diels-Alder reaction and Decarboxylation reaction).

3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)

Unit-IV: Green Synthesis / Reactions II

1. Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments.

2. Designing of Environmentally safe marine antifoulant.

3. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.

4. Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of no Trans-Fats and Oils.

Unit-V: Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.

References

1.Ahluwalia, V.K., Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers (2005). 2. Anastas, P.T. & Warner, J.K, Green Chemistry- Theory and Practical, Oxford University Press (1998).
3. Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).
4. Cann, M.C.andConnely, M.E. Real-World cases in Green Chemistry, ACS (2000).
5. Ryan, M.A. and Tinnesand, M. Introduction to Green Chemistry, American Chemical Society, (2002).
6. Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, Second Edition, 2010.

COURSE OUTCOMES

The learner shall be able to understand

- Green chemistry and its principles.
- Green synthesis and reactions.
- Green chemistry for sustainable solutions.
- Understanding principles of green chemistry etc.

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Semester VII
Practical
701: Green Chemistry

COURSE OBJECTIVE

After completion of the course, the learner shall be able to understand

- Preparation and characterization of nanoparticles of gold using tea leaves.
- Preparation of biodiesel from vegetable/ waste cooking oil.
- Different reactions and rearrangement.

Course content

1. Preparation and characterization of nanoparticles of gold using tea leaves.
2. Preparation of biodiesel from vegetable/ waste cooking oil.
3. Use of molecular model kit to stimulate the reaction to investigate how the atom economy illustrates Green Chemistry.
4. Reactions like addition, elimination, substitution and rearrangement may also be studied for the calculation of atom economy.
5. Benzoin condensation using Thiamine Hydrochloride as a catalyst (instead of cyanide).
6. Extraction of D-limonene from orange peel using liquid CO_2 prepared form dry ice.
7. Mechanochemical solvent free synthesis of azomethines
8. Solvent free, microwave assisted one pot synthesis of phthalocyanine Cu(II) complex.
9. Photoreduction of benzophenone to benzopinacol in presence of sunlight.

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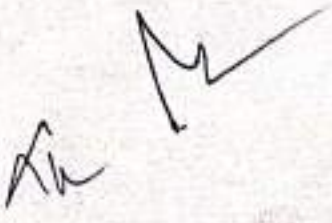
1. Anastas, P.T & Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC (2002).
3. Ryan, M.A. Introduction to Green Chemistry, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R.K.; Sidhwani, I.T. and Chaudhari, M.K. I.K. Green Chemistry Experiment: A monograph, International Publishing ISBN 978-93-81141-55-7 (2013).
5. Cann, M.C. and Connelly, M. E. Real world cases in Green Chemistry, American Chemical Society (2008).
6. Cann, M. C. and Thomas, P. Real world cases in Green Chemistry, American Chemical Society (2008).
7. Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, Second Edition, 2010.
8. Pavia, D. L., Lampman, G.M., Kriz, G.S. & Engel, R.G. Introduction to Organic Laboratory Techniques: A Microscale and Macro Scale Approach, W.B. Saunders, 1995.

COURSE OUTCOMES

The learner shall be able to understand

- Preparation and characterization of nanoparticles of gold using tea leaves.
- Preparation of biodiesel from vegetable/ waste cooking oil etc.
- Different reactions and rearrangement.



Subject II
DSE-IV
Semester VII
702: Environmental Chemistry

COURSE OBJECTIVE

After completion of the course, the learner can be able to understand

- Compositon of atmosphere
- Biogeochemical cycles
- Hydrological cycle
- Water quality parameters
- Atomospheric chemical phenomon and environmental pollution
- Water pollution, parameters of water pollution, treatment of polluted water.

Unit-I: Environment

Composition of atmosphere, temperature variation of earth atmospheric system (temperature vs. altitude curve), biogeochemical cycles of C, N, P, S and O system.

Unit-II: Hydrosphere

Hydrological cycle, aquatic pollution and water quality parameters – Dissolve oxygen, biochemical oxygen demand, chemical oxygen demand, Analytical methods for the determination fluoride, chromium and arsenic, residual chlorine and chlorine demand, purification and treatment of municipal water and waste water.

Unit-III: Atmosphere

Chemical composition of atmosphere - particle, ions, and radicals in their formation, chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, and O and their effect, pollution by chemicals, CFC, Green House effect, acid rain, air pollution and control.

Unit-IV: Aquatic chemistry

Water and its necessities, various water quality parameters (DO, BOD, COD, conductivity, pH, alkalinity, hardness) and its determination, Industrial,

Unit-V: Municipal water treatment processes

Waste water treatment procedure (primary, secondary and tertiary), Solid waste treatment. Soil pollution and Noise pollution

References

1. De. A.K. Environmental Chemistry, Wiley Eastern Ltd, 1990.
2. Miller T.G.Jr., Environmental Science, Wadsworth publishing House, Meerut Odum.E.P.1971. 3. Odum, E.P. (1971) Fundamentals of Ecology. Third Edition, W.B. Saunders Co., Philadelphia 4. S. E. Manahan, Environmental chemistry, 1993, Boca Raton, Lewis publisher
5. Environmental chemistry, Sharma and Kaur, 2016, Krishna publishers
6. Environmental Pollution, Monitoring and control, S.M. Khopker, 2007, New Age International. 7. Environmental chemistry, C. Baird, M. Cann, 5 thEdn, 2012, W.H.Freeman publication.
8. G. S. Sodhi Fundamental Concepts of Environmental Chemistry (Third Edition) Narosa (2009).
9. Principles of instrumental analysis: D. A. Skoog, Fifth Edition, Sauns College Publishing (London)
10. Basic concepts of analytical chemistry: S. M. Khopkar, Wiley Eastern (1995).

COURSE OUTCOMES

The learner can be able to understand

- Compositon of atmosphere
- Biogeochemical cycles
- Hydrological cycle
- Water quality parameters
- Atomospheric chemical phenomon and environmental pollution
- Water pollution, parameters of water pollution, treatment of polluted water.

Subject II
DSE-IV
Semester VII
702: Nuclear and Radiation Chemistry

COURSE OBJECTIVE

After completion of the course, the learner can be able to understand

- Introduction of Nuclear and Radiation Chemistry
- Nuclear reactions
- Radioactivity and Types of Reactions
- Radioactivity and Types of Reactions
- Nuclear pollution and Radiological safety

Unit-I: Introduction of Nuclear and Radiation Chemistry

Nucleus and its classification, nuclear forces, nuclear stability, binding energy, nuclear models. Radioactive decay (Radioactive elements, general characteristics of radioactive decay, decay kinetics - decay constant, half-life, mean life period), units of radioactivity, Transient and secular equilibria, Carbon dating and its usefulness.

Unit-II:Nuclear reactions

Bethe notation, types of nuclear reactions (n, p, α, d and γ), conservation of quantities (mass-energy and linear momentum) in nuclear reactions, reaction cross-section, compound nucleus theory and nuclear reactions. Nuclear fission: the process, fragments, mass distribution, and fission energy.

Unit-III: Radioactivity and Types of Reactions

Measurement of radioactivity, idea about accelerator and detectors, Van de Graaaf and linear acceletors, synchrontrons, Geiger-Muller detector, Scintillaton detectors, Type of nuclear reactions, Nuclear fission, Nuclear fusion, Nuclear reactor: classification of reactors, the natural uranium reactor, breeder reactor. Nuclear fusion and stellar energy.

Unit-IV: Radiation chemistry

Elementary ideas of radiation chemistry, radiolysis of water and aqueous solutions, unit of radiation chemical yield (G-value), radiation dosimetry (Fricke's dosimeter), units of radiation energy (Rad, Gray, Rontgen, RBE, Rem, Sievert)

Unit-V: Nuclear pollution and Radiological safety

Interaction of radiation with matter, Radiolysis of water, Radiation dosimetry. Radioactive isotopes and their applications, Isotopic dilution analysis, Neutron activation analysis, diposal of nuclear waste, nuclear disaster and its management (nuclear accidents and holocaust – discussion about case studies).

References

1. Friendlander G, Kennedy G and Miller J. M. Nuclear and Radiochemistry, Wiley Interscience.
2. Harvey, B. G. Introduction to Nuclear Physics & Chemistry, Prentice – Hall,
3. Overman R. T, Basic concept of Nuclear Chemistry, Chapman & Hall.
4. A. N. Nesmeyanov, Radiochemistry, MIR Publication, Moscow.
5. Spinks J. W. T. and Woods R. J. An Introduction to Radiation Chemistry, Wiley
6. Arnikar H. J., Essentials of Nuclear Chemistry, Wiley Eastern, Second Edition.

COURSE OUTCOMES

The learner can be able to understand

- Introduction of Nuclear and Radiation Chemistry
- Nuclear reactions
- Radioactivity and Types of Reactions
- Radioactivity and Types of Reactions
- Nuclear pollution and Radiological

Subject III
Minor
Semester VII
703: Research Methodology

COURSE OBJECTIVE

After completion of the course, the learner can be able to understand

- Understand the concept of research and different types of research in the context of biology
- Develop laboratory experiment related skills.
- Develop competence on data collection and process of scientific documentation
- Analyze the ethical aspects of research
- Evaluate the different methods of scientific writing and reporting

Unit-I: Basic Concepts of Research

Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs. qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

Unit-II: Data Collection and Documentation of Observations

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

Unit-III: Overview of Application to Chemistry related problems

Key chemistry research areas, cheminformatics.

Unit-IV: Ethics and Good Practical's and Art of Scientific Writing

Authors, acknowledgements, reproducibility, plagiarism, Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Power-point presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct plagiarism.

References

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.

COURSE OBJECTIVE

At the end of the course the students will be able to

- Understand the concept of research and different types of research in the context of biology
- Develop laboratory experiment related skills.
- Develop competence on data collection and process of scientific documentation
- Analyze the ethical aspects of research
- Evaluate the different methods of scientific writing and reporting

Subject I
Major
Semester VIII
801: Analytical Chemistry

COURSE OBJECTIVE

After completion of the course, the student shall be able to understand

- Familiarization with fundamentals of analytical chemistry.
- Basics of spectroscopic, thermal, electrochemical techniques
- Learning basics of separation techniques and its applications.
- Understanding analytical tools, statistical methods applied to analytical chemistry.
- Understanding principle of UV-Vis spectroscopy and its applications.
- Understanding principles of thermo-gravimetric analysis and study of thermal decomposition of materials/characterization of materials.
- Understanding basics of electro-analytical techniques and its applications.
- Understanding principles of separation technology and its use in advanced instrumentations.

Unit-I: Qualitative and quantitative aspects of analysis

Tools in analytical chemistry and their applications, Sampling, evaluation of analytical data, errors, accuracy and precision, statistical test of data; F, Q and t-test, rejection of data, and confidence intervals.

Unit-II: Spectroscopy

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

Unit-III: Vibration spectroscopy

Basic principles of instrumentation, sampling techniques. Application of IR spectroscopy for characterization through interpretation of data, Effect and importance of isotope substitution. Introduction to Raman spectra

Unit-IV: UV-Visible Spectrometry

Basic principles of instrumentation, principles of quantitative analysis using estimation of metal ions from aqueous solution, Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Unit-V Thermal analysis

Theory of thermogravimetry (TG and DTG), instrumentation, estimation of Ca and Mg from their mixture.

Electroanalytical methods: Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points, determination of p_{K_a} values.

Separation techniques: Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.

Chromatography techniques: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis using LC, GLC, TLC and HPLC.

References

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing California, USA, 1988. Christian, G.D, Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
3. Harris, D.C.: Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
4. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Saunder College Publications, (1998).
5. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood John Wiley 1979.
6. Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.
7. Khopkar, S. M., Basic Concepts of Analytical Chemistry, New Age (Second edition)1998
8. Skoog D.A., Holler F.J., Nieman T.A., Principles of instrumental analysis, 5th Edn., Brooks & Cole (1997).

Semester VIII
Practical
801: Analytical Chemistry

COURSE OBJECTIVE

The objective of course content is to give basic idea to students on Chromatography, Solvent Extractions, Analysis of soil, Spectrophotometry and Ion exchange analytical experiments.

Course content

1. Chromatography

(i) Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}.

(ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values.

iii. Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values.

(iv) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC II.

2. Solvent Extractions

(i) To separate a mixture of $Ni^{2+}$and Fe^{2+} by complexation with DMG and extracting the Ni^{2+}-DMG complex in chloroform, and determine its concentration by spectrophotometry.

(ii) Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

(ii) Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.

3. Analysis of soil

(i) Determination of pH of soil.

(ii) Total soluble salt

(iii) Estimation of calcium, magnesium, phosphate, nitrate

4. Ion exchange

(i) Determination of exchange capacity of cation exchange resins and anion exchange resins.

(ii) Separation of metal ions from their binary mixture.

(iii) Separation of amino acids from organic acids by ion exchange chromatography.

5. Spectrophotometry

(i) Determination of pKa values of indicator using spectrophotometry.

(ii) Structural characterization of compounds by infrared spectroscopy.

(iii) Determination of dissolved oxygen in water.

(iv) Determination of chemical oxygen demand (COD).

(v) Determination of Biological oxygen demand (BOD).

(vi) Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

References

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

2. Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.

3. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.

4. Harris, D.C. Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.

5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.

6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.

7. Mikes, O. &Chalmes, R.A. Laboratory Handbook of Chromatographic & Allied Methods, Elles Harwood Ltd. London.

8. Ditts, R.V. Analytical Chemistry: Methods of separation. Van Nostrand, New York, 1974.

COURSE OUTCOMES

After completion of the course, the student shall be able to understand

- Chromatography
- Analysis of soil
- Spectrophotometry
- Ion exchange

Subject II
DSE-V
Semester VIII
802: Heterocyclic Chemistry

COURSE OBJECTIVE

After completion of the course, the student shall be able to understand

- Three-membered rings with one heteroatom
- Three-membered heterocycles with two heteroatoms
- Four-membered heterocycles
- Five-membered aromatic heterocycles
- Condensed five-membered Heterocycles

Unit-I: Three-membered rings with one heteroatom

Chemistry of oxiranes, aziridines and episulphides- synthetic approaches and reactivities.

Unit-II: Three-membered heterocycles with two heteroatoms

oxaziranes, diaziridines and diazirines - synthetic approaches and reactivities.

Unit-III: Four-membered heterocycles

oxitanes, azatidanes and thietanes - synthetic approaches and reactivities. natural products:synthesis of Peniciline and cephalosporine.

Unit-IV: Five-membered aromatic heterocycles

1. With one heteroatom: furans, pyrroles and thiophenes - general synthetic approaches, properties and reactivities.

2. With two heteroatoms: oxazoles, isoxazoles, imidazoles, thiazoles, pyrazoles and isothiazoles - general synthetic approaches and reactivities.

3. With three and four heteroatoms: triazoles and tetrazoles - synthetic approaches, properties and reactivity.

Unit-V: Condensed five-membered Heterocycles

Benzofuran, indoles and benzothiazoles - general synthetic approaches, with greater emphasis on the chemistry of Indoles.

References

1. Heterocyclic Chemistry, J.A. Joule, K. Mills, Wiley, 2010.

2. The Essence of heterocyclic Chemistry, A. R. Parikh, H. Parikh, R. Khunt, New Age Int. Publication, 3. Principles of Modern Heterocyclic Chemistry, L. A. Paquette, W. A. Benjamin, New York, 1968.

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5. Comprehensive Heterocyclic Chemistry. The structure, reactions, synthesis and use of Heterocyclic compounds, (Ed. A.R. Katritzky and C. W. Rees), Vol 1-8, Pergamon Press, 1984.

6. Handbook of Heterocyclic Chemistry, A. R. Katritzky, Pergamon Press, 1985.

7. Van der plas, H. C. Ring transformations of Heterocycles, Vols 1 and 2, Academic Press, 1974.

COURSE OUTCOMES

The student shall be able to understand

- Three-membered rings with one heteroatom
- Three-membered heterocycles with two heteroatoms
- Four-membered heterocycles
- Five-membered aromatic heterocycles
- Condensed five-membered Heterocycles

Subject II
DSE-V
Semester VIII
802: Introduction to Nano-chemistry and Applications

COURSE OBJECTIVE

After completion of the course, the student shall be able to understand

- Nanoscience
- Nanomaterials
- Nanomaterial
- Photoelectron spectroscopy

Unit-I

Introduction to nanoscience, nanostructure and nanotechnology (basic idea), Overview of nanostructures and nano-materials, classification, (cluster, colloid, nanoparticles, and nanostructures - Spheroid, Wire, Rod, Tube, and Quantum Dot).

Unit-II

Calculation of percentage of surface atom and surface to volume ratio of spherical, wire, rod, and disc shapes nanoparticles.

Unit-III

Size dependent properties of nanomaterials (basic idea with few examples only): Quantum confinement, Electrical, Optical (Surface Plasmon resonance), variation in colors (Blue shift & Red shift), Magnetic, thermal and catalytic properties.

Unit-IV

Synthesis of Nanomaterials: Brief introduction about Top-down and Bottom-up approaches & self-assembly techniques of nanoparticles synthesis, Solvothermal process, Examples of preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-controlof nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires.

Unit-V

Material characterization techniques (basic idea of use of following instruments in nanomaterial characterization need to be emphasized): Electron microscopic technique, diffraction technique, photoelectron spectroscopy, zeta-potential measurement; Examples of use of nanomaterials in environmental remediation and biology (few practical examples of use of materials can be discussed).

References

1. C. N. R. Rao, A. Muller, A. K. Cheetam, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Willey-VCH Verlag, Germany, 2005.
2. G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Appications, Imperial College Press, London, 2004
3.R. W. Kelsall, I. W. Hameley, M. Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, England, 2005
4. Charles P. Poole and Frank J Owens, Introduction to nano technology, Wiley Interscience, 2003. UGC DOCUMENT ON LOCF CHEMISTRY 115
5. Pradeep, T., A text of book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.

COURSE OBJECTIVE

The student shall be able to understand

- Nanoscience
- Nanomaterials
- Nanomaterial
- Photoelectron spectroscopy