K.R. MANGALAM UNIVERSITY

THE COMPLETE WORLD OF EDUCATION

SCHOOL OF BASIC AND APPLIED SCIENCES

Bachelor of Science (Honours) Chemistry

B.Sc. (Hons.) Chemistry

Programme Code: 10

2021-24

Approved in the 26th Meeting of Academic Council Held on 11 August 2021

Member Secretary
Academic Council
K.R. Mangalam University

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

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PREAMBLE

The objective of any programme at the Higher Education Institute is to prepare their students for the society at large. The K. R. Mangalam University visualizes all its programmes in the best interest of their students and in this endeavour; it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Undergraduate programmes. The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate Programmes will prepare the students for both, academia and employability. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to emotional stability, well-being, critical thinking and skills for employability.

The new curriculum of B.Sc. (Hons) Chemistry offer courses in the areas of inorganic, organic, physical, materials and analytical. All the courses have defined objectives and Learning Outcomes, which will help prospective students in choosing the elective courses to broaden their skills in the field of chemistry and interdisciplinary areas. The courses will train students with sound theoretical and experimental knowledge that suits the need of academics and industry. The courses also offer ample skills to pursue research such as career in the field of chemistry and allied areas. The K. R. Mangalam University hopes the LOCF approach of the programme B.Sc. (Hons) Chemistry will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

Prepared by:

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Associate Professor	Assistant Professor	Assistant Professor	Assistant Professor

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1. Introduction

K.R. Mangalam University located on Sohna Road, Gurugram, is one of the fastest growing and most promising upcoming universities in India. It is a State Private University established in 2013 by an act of the legislature of the Haryana Government under Haryana Private Universities Act (Amendment) 8 of 2013.It is recognized by the UGC under Section 2f of the UGC Act, 1956. The primary aim of the University is to promote excellence in basic and professional education while upholding moral values.

KRMU offers sixty-eight Undergraduate, Postgraduate and Doctoral Degree programs across different disciplines. The group of educational units in the University promotes education in the areas of Engineering& Technology, Legal Studies, Basic and Applied Sciences, Management Sciences, Commerce, Journalism and Mass Communication, Hotel Management and Catering Technology, Medical and Allied Sciences, Architecture and Planning, Agriculture, Fashion Designing, Humanities and Education. All the disciplines follow a well-defined curriculum design keeping in view the guidelines of UGC/AICTE and appropriate regulatory bodies like Council of Architecture (COA), Bar Council of India (BCI), Pharmacy Council of India (PCI), National Council for Teachers Education (NCTE) etc., wherever applicable. All courses are semester and credit based.

K. R. Mangalam University is unique because of its

- An enduring legacy of providing education to high achievers who demonstrate leadership in diverse fields.
- Protective and nurturing environment for teaching, research, creativity, scholarship, social and economic justice.

Objectives

i. To impart undergraduate, post-graduate and Doctoral education in identified areas of higher education.

ii. To undertake research programmes with industrial interface.

iii. To integrate its growth with the global needs and expectations of the major stake holders through teaching, research, exchange & collaborative programmes with foreign, Indian Universities/Institutions and MNCs.

iv. To act as a nodal center for transfer of technology to the industry

v. To provide job oriented professional education to the pecia student community with particular focus on Haryana.

2. About the School

The school imparts both teaching and research through its various science disciplines viz Mathematics, Chemistry and Physics. School of Basic and Applied Sciences imparts students disciplinary knowledge, enhances their skills and ability, motivating them to think ingeniously, helping them to act independently and take decisions accordingly in all their scientific pursuits and other endeavors. It strives to empower its students and faculty members to contribute for the development of society and Nation.

The faculty is in constant touch with various experts in the relevant fields and is willing to experiment with latest ideas in teaching and research.

VISION

School of Basic and Applied Sciences intends for continuum growth as centre of advanced learning, research and innovation by disseminating analytical and scientific knowledge in the areas of basic and applied sciences by promoting interdisciplinary research and scientific acumen.

MISSION

M1: Enable students to be scientists/ academicians /entrepreneurs by accomplishing fundamental and advanced research in diverse areas of basic and applied sciences.

M2: Build strong associations with academic organizations/industries for knowledge creation, advancement, and application of scientific fervor.

M3: Create conducive environment for lifelong learning.

M4: Empower students to be socially responsible and ethically strong individuals through value-based science education.

3. Programmes offered by the school

School offers undergraduate B.Sc. (Hons) Programmes, postgraduate M.Sc. Programmes, and Doctoral Programmes. All these programmes are designed to impart scientific knowledge to the students and are aimed at providing theoretical as well as practical training in their respective fields.

School offers undergraduate B.Sc. (Hons) Chemistry from 2013. This course emphasized hands on practice, innovative thought process and project-based learning.

Graduate Attributes

GA1: To demonstrate competence in discipline specific theoretical and practical Knowledge
GA2: To develop creativity and innovation
GA3: To enhance communication and interpersonal skills
GA4: To enable critical & logical thinking and investigative research attitude amongst students
GA5: To develop ethical values, teamwork and lifelong learning approach

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 1: To apply the basic principles of chemistry to the events occurring around us and also in the world.

PEO 2: To ignite the interest for research in students.

PEO 3: To employ logical reasoning, analytical, numerical ability and theoretical skills to model real-world problems and solve them.

PEO 4: To develop critical thinking, creative thinking, and self-confidence for eventual success in career.

PEO 5: To endow the students with creative and analytical skills; this will equip them to become entrepreneurs.

PEO 6: To acquire rewarding career/placement in educational institutions, engineering and industrial firms.

Programme Outcomes (POs)

PO1. Enhancement in Advanced Scientific knowledge about chemistry
PO2. Development of critical, logical and innovative thinking
PO3. Demonstrate interdisciplinary approach
PO4. Learning of fundamental concepts and instrumentation techniques
PO5. Orientation towards research and development
PO6. Acquiring capability to work independently as well as a member of the diverse team
PO7. Understanding of impact of chemicals on the environment
PO8. Fostering communication skills
PO9. Ethical awareness and digital literacy
PO10. Capability to deal with professional responsibilities

4. B. Sc. (Hons.) Chemistry

This course aims to impart basic and applied knowledge in various branches in Chemistry with a view to produce good academics, researchers and professionals in the field.

Eligibility Criteria: -The student should have passed the 10+2 examination conducted by theCentral Board of Secondary Education or equivalent examination from a recognized Board in Science stream with an aggregate of 50% or more.

Course Outline: -Inorganic chemistry / Organic chemistry / Physical chemistry / Analyticalmethods in chemical sciences / Environmental chemistry / Biochemistry / Green Chemistry.

Career Options: -Opportunities exist in chemical industry, pharmacy, education.

Programme Specific Outcome (PSOs)

PSO1. Systematic and coherent understanding of theoretical and practical concepts

PSO2. Appreciate the techniques for the qualitative and quantitative analysis.

PSO3. Learn problem solving approach.

PSO4. Apply principles of chemistry to address societal problems.

5. Programme Duration

The minimum period required for the B.Sc. Program and B.Sc. (Hons.) Programme offered by the University shall extend over a period of three Academic Years.

The maximum period for the completion of the B.Sc. Program and B.Sc. (Hons) Programme offered by the University shall be five years.

6. Class Timings

The classes will be held from Monday to Friday from 09:10 am to 04:10 pm.

7. Scheme of Studies and Syllabi

The syllabi of B.Sc. (H) Chemistry for all years offered by SBAS with scheme of studies are given in the following pages.

B.Sc. (H) Chemistry Programme at a Glance

SEMESTER	I	II	III	IV	V	VI	TOTAL
COURSES	9	9	11	11	9	9	**56**
CREDITS	26	27	29	27	24	30	**163**

SCHEME OF STUDIES AS PER CHOICE-BASED CREDIT SYSTEM (CBCS) AND LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

SEMESTER I							
S.No.	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**	**Total Hours**
1	BSCH106A	INORGANIC CHEMISTRY-I	3	1	0	4	4
2	BSCH156A	INORGANIC CHEMISTRY-I PRACTICALS	0	0	4	2	4
3	BSCH103A	ORGANIC CHEMISTRY-I	3	1	0	4	4
4	BSCH153A	ORGANIC CHEMISTRY-I PRACTICALS	0	0	4	2	4
5	UCES 125A	ENVIRONMENTAL STUDIES	3	0	0	3	3
6	UCDM 301A	DISASTER MANAGEMENT	3			3	3
7	BSCH132A	FERMENTATION SCIENCE AND TECHNOLOGY	2	0	0	2	2
8	BSCH109A	HERBAL TECHNOLOGY	2	0	0	2	2
9		GENERIC ELECTIVE-I/OPEN ELECTIVE-I	4	0	0	4	4
TOTAL						**27**	**31**

SEMESTER II							
S.No	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**	**Total Hours**
1	BSCH102A	PHYSICAL CHEMISTRY-I	3	1	0	4	4
2	BSCH152A	PHYSICAL CHEMISTRY-I PRACTICALS	0	0	4	2	4
3	BSCH108A	ORGANIC CHEMISTRY-II	3	1	0	4	4
4	BSCH158A	ORGANIC CHEMISTRY-II PRACTICALS	0	0	4	2	4
5	UCCS 155A	COMMUNICATION SKILLS	4	0	0	4	4
6	ETCS104A	INTRODUCTION TO COMPUTERS AND PROGRAMMING IN PYTHON	3	1	0	4	4
7	ETCS150A	INTRODUCTION TO COMPUTERS AND PROGRAMMING IN PYTHON LAB	0	0	2	1	2
8	BSCH110A	INTELLECTUAL PROPERTY RIGHT (IPR) AND BUSINESS SKILLS FOR CHEMISTS	2	0	0	2	2
9		GENERIC ELECTIVE-I/OPEN ELECTIVE-II	4	0	0	4	4
TOTAL						**27**	**32**

SEMESTER III							
S.No	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**	**Total Hours**
1	BSCH201A	PHYSICAL CHEMISTRY-II	3	1	0	4	4
2	BSCH251A	PHYSICAL CHEMISTRY-II PRACTICALS	0	0	4	2	4
3	BSCH203A	ORGANIC CHEMISTRY-III	3	1	0	4	4
4	BSCH253A	ORGANIC CHEMISTRY-III PRACTICALS	0	0	4	2	3
5	BSCH205A	ANALYTICAL TECHNIQUES OF CHEMISTRY	3	1	0	4	4
6	BSCH255A	ANALYTICAL TECHNIQUES OF CHEMISTRY PRACTICALS	0	0	4	2	3
7		GENERIC ELECTIVE COURSE-III	3	1	0	4	4
8		GENERIC ELECTIVE COURSE-III PRACTICALS	0	0	4	2	4
9	ETCS109A	DATA ANALYSIS AND VISUALIZATION	2	0	0	2	2
10	ETCS159A	DATA ANALYSIS AND VISUALIZATION LAB	0	0	2	1	2
11		MOOC	0	0	0	2	0
TOTAL						**29**	**34**

SEMESTER IV							
S.No	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**	**Total Hours**
1	BSCH202A	PHYSICAL CHEMISTRY-III	3	1	0	4	4
2	BSCH252A	PHYSICAL CHEMISTRY-III PRACTICALS	0	0	4	2	4
3	BSCH206A	INORGANIC CHEMISTRY-II	3	1	0	4	4
4	BSCH254A	INORGANIC CHEMISTRY-II PRACTICALS	0	0	4	2	4
5	BSCH208A	INTRODUCTION TO QUANTUM CHEMISTRY	3	1	0	4	4
6	BSCH256A	INTRODUCTION TO QUANTUM CHEMISTRY PRACTICALS	0	0	4	2	4
7		GENERIC ELECTIVE COURSE-IV	3	1	0	4	4
8		GENERIC ELECTIVE COURSE-IV PRACTICALS	0	0	4	2	4
9	BSMA274A	INTRODUCTION TO LATEX	0	0	2	1	2
10		VALUE ADDED COURSE	0	0	0	0	0
11	BSCH210A	INTERNSHIP IN CHEMISTRY (25 Days)	0	0	0	2	0
TOTAL						**27**	**34**

SEMESTER V							
S.No	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**	**Total Hours**
1	BSCH301A	INORGANIC CHEMISTRY-III	3	1	0	4	4
2	BSCH351A	INORGANIC CHEMISTRY-III PRACTICALS	0	0	4	2	4
3	BSCH303A	MOLECULAR SPECTROSCOPY AND PHOTOCHEMISTRY	3	1	0	4	4
4	BSCH353A	MOLECULAR SPECTROSCOPY AND PHOTOCHEMISTRY PRACTICALS	0	0	4	2	4
5		DISCIPLINE ELECTIVE COURSE-I	3	1	0	4	4
6		DISCIPLINE ELECTIVE COURSE-I PRACTICALS	0	0	4	2	4
7		DISCIPLINE ELECTIVE COURSE-II	3	1	4	4	4
8		DISCIPLINE ELECTIVE COURSE-II PRACTICALS	0	0	4	2	4
9		VALUE ADDED COURSE	0	0	0	0	0
TOTAL						**24**	**32**

SEMESTER VI							
S.No	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**	**Total Hours**
1	BSCH311A	BIOMOLECULES	4	0	0	4	4
2	BSCH361A	BIOMOLECULES LAB	0	0	4	2	4
3	BSCH302A	CHEMISTRY OF MATERIALS	3	1	0	4	4
4	BSCH352A	CHEMISTRY OF MATERIALS PRACTICALS	0	0	4	2	4
5		DISCIPLINE ELECTIVE COURSE-III	3	1	0	4	4
6		DISCIPLINE ELECTIVE COURSE-III PRACTICALS	0	0	4	2	4
7		DISCIPLINE ELECTIVE COURSE-IV	3	1	4	4	4
8		DISCIPLINE ELECTIVE COURSE-IV PRACTICALS	0	0	4	2	4
9	BSCH358A	RESEARCH PROJECT	0	0	2	6	2
TOTAL						**30**	**34**

Electives (Choose any one from each)

DISCIPLINE SPECIFIC ELECTIVE- I						
S.No.	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1.	BSCH305A	MEDICINAL CHEMISTRY	3	1	0	**4**
2.	BSCH355A	MEDICINAL CHEMISTRY PRACTICALS	0	0	4	**2**
3.	BSCH307A	HETREOCYCLIC CHEMISTRY	3	1	0	**4**
4.	BSCH357A	HETREOCYCLIC CHEMISTRY PRACTICALS	0	0	4	**2**
DISCIPLINE SPECIFIC ELECTIVE -II						
5.	BSCH309A	ADVANCE MATERIAL CHEMISTRY	3	1	0	**4**
6.	BSCH359A	ADVANCE MATERIAL CHEMISTRY PRACTICALS	0	0	4	**2**
7.	BSCH321A	ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY	3	1	0	**4**
8.	BSCH371A	ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY PRACTICALS	0	0	4	**2**

DISCIPLINE SPECIFIC ELECTIVE- III						
9.	BSCH304A	ENVIRONMENTAL CHEMISTRY	3	1	0	**4**
10.	BSCH354A	ENVIRONMENTAL CHEMISTRY PRACTICALS	0	0	4	**2**
11.	BSCH306A	ORGANIC SPECTROSCOPY	3	1	0	**4**
12.	BSCH356A	ORGANIC SPECTROSCOPY PRACTICALS	0	0	4	**2**
DISCIPLINE SPECIFIC ELECTIVE- IV						
13.	BSCH308A	INTRODUCTION OF NANOCHEMISTRY AND APPLICATIONS	3	1	0	**4**
14.	BSCH368A	INTRODUCTION OF NANOCHEMISTRY AND APPLICATIONS PRACTICALS	0	0	4	**2**
15.	BSCH310A	GREEN PROCESSES OF CHEMISTRY	3	1	0	**4**
16.	BSCH360A	GREEN PROCESSES OF CHEMISTRY PRACTICALS	0	0	4	**2**
17.	BSCH332A	POLYMER CHEMISTRY	3	1	0	**4**
18.	BSCH372A	POLYMER CHEMISTRY PRACTICALS	0	0	4	**2**

Students can choose two noncreditvalue-added courses (3 hours per week), one in 4th semester and one in 5th semester during the entire duration of Programme from the pool of courses provided by the university.

Students can choose available MOOCs recommended by Dean Academics and approved by Vice Chancellor of K. R. Mangalam University, from the list of approved MOOCs by SWAYAM Board in each semester.

A student must do Internship of 25 days in 4th Semester; the university will provide NOC for the same.

Syllabi of Courses to B.Sc. (Hons.) Chemistry

Semester-I

BSCH106A	**Inorganic Chemistry-I**	L	T	P	C
Version 3.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of atoms and bonding in molecules				
Co-requisites	--				

Course Objectives

1. To learn the students about theories of atomic structure and different principles
2. To learn the student's various properties of elements in periodic table
3. To study about the ionic and covalent bonding in compounds and general characteristics
4. To enable the students competently matters of metallic bonding and weak chemical forces.

Course Outcomes

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

CO1. Remember fundamental concepts related to atoms and their structure.
CO2. Understand the principles governing atomic structure.
CO3. Apply knowledge of bonding theories to predict molecular geometries and properties.
CO4. Analyze complex molecules and determine their bonding patterns.
CO5. Evaluate the relationship between atomic structure and chemical reactivity.
CO6. Create new models or theories to explain observed chemical phenomena.

Catalog Description

In this course students will learn about the structure of atom on the basis of different theories like Bohr's atomic theory, Planck's quantum theory, de – Broglie equation and Heisenberg's uncertainty principle. Students will learn about the orbital's in atom their size, shape, orientation and periodic properties. This course helps them to get idea about the VSEPR, VBT and MOT theories of chemical bonding and crystal structures. This will also provide information of metallic and Vander Waals bonds.

Course Content

UNIT I: Atomic Structure **15 Lectures**

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 $\psi 1$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 **15 Lectures**

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.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.

(b) Atomic radii (Vander Waals)

(c) Ionic and crystal radii.

(d) Covalent radii (octahedral and tetrahedral)

(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.

(f) Electron gain enthalpy, trends of electron gain enthalpy.

(g) Electronegativity, Pauling, Mullikan, Allred Rachow scales, electronegativity and bond order, partial charge, hybridization, group electronegativity. Sanderson electron density ratio.

UNIT III: Chemical Bonding **15 Lectures**

Ionic bond: General characteristics, 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.

(i) *Covalent bond:* Lewis's 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 hetero nuclear diatomic molecules, MO diagrams of simple triand tetra-atomic molecules., N_2,O_2,C_2,B_2,F_2,CO,NO,andtheirions;HCl,BeF_2,CO_2,HCHO,(ideaofs-pmixingandorbital interaction to be given). Covalent character in ionic compounds, polarizing power and polarizability. Fajanrules,polarization.Ioniccharacterincovalentcompounds:Bondmoment and dipole moment. Ionic character from dipole moment andelectronegativities.

UNIT IV: Metallic bonding and Weak chemical forces **15 Lectures**

(ii) *Metallic Bond:* Qualitative idea of free electron model, Semiconductors, Insulators.

(iii) *Weak Chemical Forces:* Vander 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.

Textbooks

1. Lee, J. D. Concise Inorganic Chemistry, Wiley, 5th Edn.

Reference Books/Materials

1. Douglas, B.E., McDaniel, D.H., Alexander J.J., Concepts & Models of Inorganic Chemistry, (Third Edition) John Wiley & Sons, 1999.
2. Atkins, P. W. and DePaula, J. Physical Chemistry, Tenth Edition, Oxford University Press, 2014.
3. Rodger, G. E. Inorganic and Solid State Chemistry, Cengage Learning, 2002.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remember fundamental concepts related to atoms and their structure.	**PO1**
CO2	Understand the principles governing atomic structure.	**PO2**
CO3	Apply knowledge of bonding theories to predict molecular geometries and properties.	**PO1**
CO4	Analyze complex molecules and determine their bonding patterns.	**PO4**
CO5	Evaluate the relationship between atomic structure and chemical reactivity.	**PO3**
CO6	Create new models or theories to explain observed chemical phenomena	**PO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO 3	PSO4
BSCH 106A	Inorganic Chemistry-I	3	6		1	4			2			2	4	4	

1=weakly mapped; = moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	**3**													
CO2				**3**										
CO3	**3**													
CO4				**3**										
CO5			**2**											
CO6				**3**										
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH156A	Inorganic Chemistry-I Practicals	L	T	P	C
Version 3.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	12^{th} level practices and experiments				
Co-requisites	--				

Course Objectives

1. To familiarize the students with solution preparations and calibration of apparatus.
2. To expertise the students in acid-base and redox titrations for quantitative analysis.

Course Outcomes

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

CO1. Understand principles and concepts underlying titration techniques.

CO2. Apply appropriate calculations to determine the concentration of an analyte in a sample.

CO3. Analyze experimental data and calculate the volume and concentration of reactants.

CO4. Evaluate the accuracy and precision of the obtained results.

CO5. Create Report for the experiment

Catalog Description

This course imparts the understanding of quantitative analysis by titration method to find out the concentrations of unknown salt or ions present in solution. This course helps them to get experience of preparing primary and secondary standard solutions with different normality and molarity. This course also introduces the calibration of apparatus and oxidation-reduction titrations..

Course Content

(A) Titrimetric Analysis

(i) Calibration and use ofapparatus.

(ii) Preparation of solutions of different Molarity/Normality oftitrants.

(iii) Use of primary and secondary standardsolutions.

(B) Acid-BaseTitrations

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in amixture.

(iii) Estimation of free alkali present in differentsoaps/detergents

(C) Oxidation-ReductionTitrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$solution.

(ii) Estimation of oxalic acid and sodium oxalate in a givenmixture.

(iii) Estimation of Fe(II) with $K_2Cr_2O_7$using internal (diphenylamine, anthranilic acid) and externalindicator.

Textbooks

1. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis* Sixth Edition, Pearson,2009.

Reference Books/Materials

1. O. P. Pandey, D.N. Bajpai, S.Giri, Practical chemistry, S. Chand & Company Pvt. Ltd.
2. Svehala G. and Sivasankar I. B, Vogel's Qualitative Inorganic Analysis, Pearson, India, 2012.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Conduct of Experiment**	**Lab Record/Quizzes / Viva-Voce**	**Attendance**	**End Term PracticalExamination**
Weightage (%)	**20**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand principles and concepts underlying titration techniques.	**PO1**
CO2	Apply appropriate calculations to determine the concentration of an analyte in a sample.	**PO1**
CO3	Analyze experimental data and calculate the volume and concentration of reactants.	**PO2**
CO4	Evaluate the accuracy and precision of the obtained results.	**PO2**
CO5	Create Report for the experiment	

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 156A	Inorganic Chemistry-I Practicals	3	3	2		3						3	2		3

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	**3**													
CO2	**3**													
CO3		**3**												
CO4		**3**												
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH103A	Organic Chemistry-I	L	T	P	C
Version 3.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics introduction of organic chemistry				
Co-requisites	--				

Course Objectives

1. The course is infused with the recapitulation of fundamentals of organic chemistry and the introduction of a new concept of visualizing the organic molecules in a three-dimensional space.
2. To establish the applications of these concepts, the functional groups- alkanes, alkenes, alkynes and aromatic hydrocarbons are introduced.
3. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

Course Outcomes

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

CO1. Understand and explain the different nature and behavior of organic compounds based on fundamental concepts learnt.

CO2. Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.

CO3. Learn and identify many organic reaction mechanisms including Free Radical Substitution, Electrophilic Addition and Electrophilic Aromatic Substitution.

CO4. Understand the fundamental concepts of stereochemistry.

CO5. Analyze the basic difference between aliphatic and aromatic compounds.

CO6. Creation of logic behind organic chemistry.

Catalog Description

This course comprises of basics of organic chemistry, which involves concept of hybridization, various Electronic Displacements, reaction intermediates. Concept of stereochemistry is discussed. Aliphatic and aromatic hydrocarbons are also included, with preparation, physical properties and chemical properties.

Course Content

UNIT I

Basics of Organic Chemistry **15 Lectures**

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 suitableexamples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity andbasicity; Types, shape and relativestabilitiesofreactionintermediates(Carbocations,Carbanions, Free radicals and Carbenes).Organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

UNIT II

Stereochemistry **15 Lectures**

Concepto asymmetry, Fischer Projection, Newmann and Saw horse projection formulae and their inter conversions; Geometricalisomerism: cis-transand,syn-antiisomerismE/ZnotationswithC.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

Chemistry of Aliphatic Hydrocarbons **15 Lectures**

A. Carbon-Carbon sigmabonds

Chemistryofalkanes:Formationofalkanes,WurtzReaction,Wurtz-FittigReactions,Freeradical substitutions: Halogenation - relative reactivity andselectivity.

B. Carbon-Carbonpi-bonds

FormationofalkenesandalkynesbyeliminationreactionsMechanismofE1,E2,E1cbreactions.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- Alderreaction;Allylicandbenzylicbrominationandmechanism,e.g.propene,1-butene,toluene, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilicadditions.

C. Cycloalkanes and ConformationalAnalysis

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

UNIT IV

Aromatic Hydrocarbons **15 Lectures**

Aromaticity: Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocycliccompoundswithsuitableexamples.Electrophilicaromaticsubstitution: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. (PearsonEducation).
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,OrganicChemistry,2ndEd.,(2012),OxfordUniversitiy Press.
5. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism, Kluwer Academic Publisher,(2000).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand and explain the different nature and behavior of organic compounds based on fundamental concepts learnt.	**PO4**
CO2	Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.	**PO2**
CO3	Learn and identify many organic reaction mechanisms including Free Radical Substitution, Electrophilic Addition and Electrophilic Aromatic Substitution.	**PO2**
CO4	Understand the fundamental concepts of stereochemistry.	**PO1, PO4**
CO5	Analyze the basic difference between aliphatic and aromatic compounds.	**PO1**
CO6	Creation of logic behind organic chemistry.	**PO2**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 103A	ORGANIC CHEMISTRY-I	3	3		3									2	3

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1		**3**									**3**			
CO2		**3**												
CO3				**3**							**3**			
CO4				**3**										
CO5		**3**									**2**			
CO6		**2**												
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH153A	Organic Chemistry-I Practicals	L	T	P	C
Version 3.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of reaction mechanism				
Co-requisites	--				

Course Objectives

1. To enable the student for hands on learning by experiments.
2. To generate confidence among students to perform reactions or analysis.

Course Outcomes

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

CO1. Understand the calibration of instruments.

CO2. Evaluate the boiling points and melting points correctly.

CO3. Understand the chromatographic techniques.

CO4. Analyze the separation of mixture.

CO5. Learn about purification of substances.

CO6. Learn about the environment safety at the time of performing experiment.

Catalog Description

This course provides information regarding Calibration of instruments, Purification of organic compounds and determination of boiling points, melting points of organic compounds. Chromatographic techniques (TLC) are the important part this course.

Course Content **30 lecture**

1. Checking the calibration of thethermometer.
2. Purification of organic compounds by crystallization using the followingsolvents:

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 pointapparatus).
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 capillarymethod)
5. Chromatography

a. Separation of a mixture of two amino acids by ascending and horizontal paperchromatography

b. Separation of a mixture of two sugars by ascending paperchromatography

c. Separation of a mixture of *o*-and *p*-nitrophenol or o-and p-aminophenol by thin layer chromatography(TLC).

Recommended Books/Reference:

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)

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes/ Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Understand the calibration of instruments.	PO4,
CO2	Evaluate the boiling points and melting points correctly.	PO4
CO3	Understand the chromatographic techniques.	PO1
CO4	Analyze the separation of mixture.	PO1, PSO1
CO5	Learn about purification of substances.	PO4, PSO4
CO6	Learn about the environment safety at the time of performing experiment.	PO7, PSO4

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 153A	ORGANIC CHEMISTRY-I PRACTICALS	3			3			3				3	3	2	3

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1				**3**										
CO2				**3**										
CO3	**3**													
CO4	**3**													
CO5				**3**										
CO6							**3**							
1=lightly mapped 2= moderately mapped 3=strongly mapped														

UCES125A	Environmental Studies	L	T	P	C
Version 2.0		3	0	0	3
Total Contact Hours	45				
Pre-requisites/Exposure	Basics of Environment				
Co-requisites	--				

Course Objectives

1. To aware the students about the environment.
2. To learn the concepts and methods from ecological and physical sciences and their application in solving environmental issues.
3. To think across and beyond existing disciplinary boundaries, mindful of the diverse forms of knowledge and experience that arises from human interactions with the world around them.
4. To communicate clearly and competently matters of environmental concern before the audience after analyzing the data.

Course Outcomes

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

CO1. Comprehend and become responsive regarding environmental issues

CO2. Acquire the techniques to protect our mother earth, as without a clean, healthy, aesthetically beautiful, safe and secure environment no species can survive and sustain.

CO3. Enable the students to discuss their concern at national and international level with respect to formulate protection acts and sustainable developments policies.

CO4. Know that the rapid industrialization, crazy consumerism and over-exploitation of natural resources have resulted in degradation of earth at all levels and find solutions for the same.

CO5. Become consciousness about healthy and safe environment.

Catalog Description

This course imparts the basic concepts of environment which enable them to solve basic problems related to their surroundings. This course helps them to get an idea adverse effect of industrialization, population and degradation of natural resources on the environment. The course introduces the concepts of renewable and non-renewable resources.

Course Content

UNIT I **15Lectures**

Environment and Natural Resources:

Multidisciplinary nature of environmental sciences; Scope and importance; Need for public awareness. Land resources; land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state). Energy resources: Renewable and non- renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

UNIT II **15 Lectures**

Ecosystems and Biodiversity:

Ecosystem: Definition and Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession.Case studies of the following ecosystems:

a) Forest ecosystem

b) Grassland ecosystem

c) Desert ecosystem

d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots ; India as a mega-biodiversity nation; Endangered and endemic species of India; Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity; Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

UNIT III **15 Lectures**

Environmental Pollution and Environmental Policies:

Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution Nuclear hazards and human health risks; Solid waste management: Control measures of urban and industrial waste; Pollution case studies.

Sustainability and sustainable development; Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture; Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; wildlife Protection Act; Forest Conservation Act; Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context. Fundamentals and Application of ESG (Environment Social Governance).

UNIT IV **15 Lectures**

Human Communities and the Environment and Field work:

Human population growth: Impacts on environment, human health and welfare; Resettlement and rehabilitation of project affected persons; case studies; Disaster management: floods, earthquake, cyclones and landslides; Environmental movements: Chipko, Silent valley, Bishnoi's of Rajasthan; Environmental ethics: Role of Indian and other religions and cultures in environmental conservation; Environmental communication and public awareness, Recent Case studies related to earthquakes, Foods, Famine, Water Crisis/Scarcity, Smog, Water contamination at National and International Level.

Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.

Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.

Study of common plants, insects, birds and basic principles of identification.

Study of simple ecosystems-pond, river, Delhi Ridge, etc.

Textbooks

1. Kaushik and Kaushik, Environmental Studies, New Age International Publishers (P) Ltd. New Delhi.

Reference Books/Materials

1. A.K. De, Environmental Chemistry, New Age International Publishers (P) Ltd. New Delhi.
2. S.E. Manahan, Environmental Chemistry, CRC Press.
3. S.S Dara and D.D. Mishra, Environmental Chemistry and Pollution Control, S.Chand & Company Ltd, New Delhi.
4. R. Gadi, S. Rattan, S. Mohapatra, Environmental Studies Kataria Publishers, New Delhi.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	The learners will be able to comprehend and become responsive regarding environmental issues.	PO6
CO2	Students will acquire the techniques to protect our mother earth, as without a clean, healthy, aesthetically beautiful, safe and secure environment no specie can survive and sustain.	PO10
CO3	It enables the students to discuss their concern at national and international level with respect to formulate protection acts and sustainable developments policies.	PO8
CO4	Students come to know that the rapid industrialization, crazy consumerism and over-exploitation of natural resources have resulted in degradation of earth at all levels.	PO9
CO5	Students become consciousness about healthy and safe environment.	PO2

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 125A	Environmental Studies		2				3		3	3	2			3	

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1							**3**							
CO2							**3**			**3**				
CO3								**3**						3
CO4							**3**		**3**					3
CO5										**3**				
1=lightly mapped 2= moderately mapped 3=strongly mapped														

UCDM301A	Disaster Management	L	T	P	C
Version 1.0		3	0	0	3
Total Contact Hours	45				
Pre-requisites/Exposure	Basics of Disasters and control techniques				
Co-requisites	--				

Course Objectives

1. To create awareness about various types of disasters.
2. To educate the students about basic disaster management strategies and problem solving.
3. To examine disaster profile of our country and illustrates the role of governmental and non- governmental organizations in its effective management.
4. To acquaints students with the existing legal frame work for disaster management and understanding the appropriate rules and regulations.

Course Outcomes

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

CO1. To enable the students to know the difference between natural and man- made disaster
CO2. To acquire the knowledge related to disaster preparedness
CO3. To aware the student about recovery after disaster
CO4. To know the structure and functioning of disaster management framework of our country
CO5. To provide the knowledge about disaster management act

Catalog Description

This course imparts the basic concepts of environment which enable them to solve basic problems related to their surroundings. This course helps them to get an idea adverse effect of industrialization, population and degradation of natural resources on the environment. The course introduces the concepts of renewable and non-renewable resources.

Course Content

UNIT I **7 Lectures**

Introduction to Disasters:

Concept and definitions- Disaster, Hazard, vulnerability, resilience, risks.Different Types of Disaster: Causes, effects and practical examples for all disasters. Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc. Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism etc.

UNIT- II **7 Lectures**

Disaster Preparedness

Concept and Nature, Disaster Preparedness Plan, Prediction, Early Warnings and Safety Measures of Disaster, Role of Information, Education, Communication, and Training, Role of Government, International and NGO Bodies, Role of IT in Disaster Preparedness, Role of Engineers on Disaster Management, Relief and Recovery, Medical Health Response to Different Disasters

UNIT III **8 Lectures**

Rehabilitation, Reconstruction and Recovery

Reconstruction and Rehabilitation as a Means of Development, Damage Assessment, Post Disaster effects and Remedial Measures, Creation of Long-term Job Opportunities and Livelihood Options, Disaster Resistant House Construction, Sanitation and Hygiene, Education and Awareness, Dealing with Victims' Psychology, Long-term Counter Disaster Planning, Role of Educational Institute.

UNIT IV **8 Lectures**

Disaster Management in India

Disaster Management Act, 2005: Disaster management framework in India before and after Disaster Management Act, 2005, National Level Nodal Agencies, National Disaster Management AuthorityLiabilityforMassDisaster: Statutoryliability, Contractualliability, Tortiousliability, Criminalliability,MeasureofdamagesEpidemics Diseases Act, 1897: Main provisions, loopholes.Applications of AI and ML in Disaster Management and risk predictions.

Textbooks

1. Content building programme (CBP) book on Disaster Management, Forum AS.

Reference Books/Materials

1. Government of India, Department of Environment, Management of Hazardous Substances Control
2. Act and Structure and Functions of Authority Created Thereunder.
3. Indian Chemical Manufacturers' Association & Loss Prevention Society of India, Proceedings of the National Seminar on Safety in Road Transportation of Hazardous Materials: (1986).
4. Author Title Publication Dr. Mrinalini Pandey Disaster Management Wiley India Pvt. Ltd.
5. Tushar Bhattacharya Disaster Science and Management McGraw Hill Education (India) Pvt. Ltd.
6. Jagbir Singh Disaster Management: Future Challenges and Opportunities K W Publishers Pvt. Ltd.
7. J. P. Singhal Disaster Management Laxmi Publications.
8. Shailesh Shukla, Shamna Hussain Biodiversity, Environment and Disaster Management Unique Publications

9. C. K. Rajan, Navale Pandharinath Earth and Atmospheric Disaster Management: Nature and Manmade B S Publication
10. Indian law Institute (Upendra Baxi and Thomas Paul (ed.), Mass Disasters and Multinational Liability: The Bhopal Case (1986)
11. Indian Law Institute, Upendra Baxi (ed.), Environment Protection Act: An Agenda for Implementation (1987)
12. Asian Regional Exchange for Prof. Baxi., Nothing to Lose But our Lives: Empowerment to Oppose
13. Industrial Hazards in a Transnational world (1989)
14. Gurudip Singh, Environmental Law: International and National Perspectives (1995), Lawman (India) Pvt. Ltd.
15. Leela Krishnan, P, The Environmental Law in India, Chapters VIII, IX and X (1999), Butterworths, New Delhi.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz I	Quiz II	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	To enable the students to know the difference between natural and man- made disaster	PO6
CO2	Acquire the knowledge related to disaster preparedness	PO10
CO3	To aware the student about recovery after disaster	PO8
CO4	To know the structure and functioning of disaster management framework of our country	PO9
CO5	To provide the knowledge about disaster management act	PO2

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO 3	PSO4
BSDM 301A	Disaster Management		2				3		3	3	2			3	

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1				**3**		2								
CO2	**3**									3				
CO3								2						3
CO4									3					3
CO5	3													
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH132A	Fermentation Science and Technology	L	T	P	C
Version 1.0		2	0	0	2
Total Contact Hours	30				
Pre-requisites/Exposure	12th Standard Chemistry				
Co-requisites	--				

Course Objectives

1. To acquaint students with microbial culture and its preparation.
2. To learn methods of preservation of microbial culture.
3. To understand principles of fermentation technology.
4. To understand microbial production of some common products.

Course Outcomes

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

CO1: Learn the process for maintenance and preservation ofmicroorganisms

CO2: Analyze the various aspects of the fermentation technology and apply it for fermentative production

CO3: Demonstrate proficiency in the experimental techniques for microbial production of enzymes: amylase and protease, bio productrecovery etc.

CO4: Understand about preparation and sterilization of microbial culture

Catalog Description

Fermentation is process which is very widely used in food industry, pharmaceutical and many other industries for production of several products such as cheese, penicillin, streptomycin etc. The course provides the basic understanding about the structure of microbes such bacteria, fungus etc. How growth of these microbes occur in the fermentation media, nutrients required for their growth, and their preservation techniques etc. The knowledge about fermenters is also given.

The course gives an overview of microbes and microbial reactions which take place during fermentation of common products such as vinegar, alcohol, enzymes etc.

Course Content

UnitI 15 lecture

Preparationofmicrobialculture, preparationandsterilizationoffermentationmedia, Isolationand improvement of industrially importantmicroorganisms.Maintenance and preservation of microorganisms, metabolic regulations and overproduction of metabolites. Kinetics of microbial growth and product formation.

UnitII 15 lecture

Scopeandopportunitiesoffermentationtechnology.Principlesoffermentation:Submerged,solid state, batch, fed-batch and continuous culture. Fermentative production of vinegar, alcohol (ethanol, wine, beer), acids (citric acid and gluconic acid), amino acids (lysine and glutamic acid) and antibiotics (penicillin andstreptomycin).Microbial production of enzymes: Amylase and Protease. Bioproduct recovery.

Suggested readings

1. Waites M.J. (2008). Industrial Microbiology: An Introduction, 7th Edition, Blackwell Science, London,UK.
2. PrescottS.C.,DunnC.G.,ReedG.(1982).Prescott&Dunn'sIndustrialMicrobiology,4th Edition, AVI Pub. Co.,USA.
3. Reed G. (2004). Prescott & Dunn's industrial microbiology, 4th Edition, AVI Pub. Co., USA.
4. JR Casida L.E. (2015). Industrial Microbiology, 3rd Edition, New Age International (P) Limited Publishers, New Delhi,India.
5. WaitesM.J.,MorganN.L.,RockeyJ.S.andHigtonG.(2001)IndustrialMicrobiology:An Introduction. 1st Edition, Blackwell Science, London,UK.
6. Pelczar M.J., Chan E.C.S. and Krieg N.R. (2003) Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, NewDelhi.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Employ the process for maintenance and preservation ofmicroorganisms	**PO3**
CO2	Analyze the various aspects of the fermentation technology and apply for Fermentative production	**PO3**
CO3	Demonstrate proficiency in the experimental techniques for microbial production of enzymes: amylase and protease, bio productrecover	**PO4**
CO4	Understanding about preparation and sterilization of microbial culture	**PO3**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO 3	PSO4
BSCH 111A	**Fermentation Science and Technology**			2	2							2			1

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1			**3**											
CO2			**3**											
CO3				**3**										
CO4			**3**											
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH109A	Herbal Technology	L	T	P	C
Version 1.0		2	0	0	2
Total Contact Hours	30				
Pre-requisites/Exposure	12th Standard Chemistry				
Co-requisites	--				

Course Objectives

1. To acquaint students with different traditional systems of medicines.
2. To enable them to show methods of extraction of phytochemicals, their separation and identification of phytoconstituents
3. To learn techniques to grow them profitably and their storage and processing.
4. To learn the usage of these plant materials as cosmetic, nutraceuticals or fungicides etc.

Course Outcomes

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

CO1: Develop understanding about HerbalTechnology and principles of cultivation of herbalproducts

CO2: List the major herbs, their botanical name and chemicalconstituents and evaluate the drug adulteration through the biologicaltesting

CO3: Develop the skills for cultivation of plants and their processing / storage / qualitycontrol etc.

CO4: Gain knowledge about tissue culture and micro propagation

Catalog Description

It has been observed that synthetic medicines prepared in the laboratory are administered to patients to cure diseases cause several side effects. It is thus very important to explore our age old traditional medicinal plants or bhasms etc.so that they can be studied in a systematic way to find out their benefits. Several medicinal herbs and plants contain large number of phytoconstituents which can be used as nutraceuticals, herbal medicines, pesticides etc.

The course gives an overview of traditional systems of medicines, important herbal medicinal plants, their cultivation methods and usage.

Course Content

Unit I **8 lecture**

Herbal Technology: Definition and scope; Herbal medicines: history and scope; Traditional systems of medicine, and overview of AYUSH (Traditional Indian Systems of Medicine); Cultivation - harvesting - processing - storage of herbs and herbal products.

Unit II **8 lecture**

Value added plant products: Herbs and herbal products recognized in India; Major herbs used as herbal medicines, nutraceuticals, cosmeceuticals and biopesticides, their Botanical names, plant parts used, major chemical constituents.

Unit III **7 lecture**

Pharmacognosy - Systematic position, botany of the plant part used and active principles of the following herbs: Tulsi, Ginger, Curcuma, Fenugreek, Indian Gooseberry, *Catharanthus roseus, Withaniasomnifera,Centellaasiatica,Achyranthesaspera,*Kalmegh,Giloe(Tinospora),Saravar. Herbal foods, future of pharmacognosy.

Unit IV **7 lecture**

Analytical Pharmacognosy: Morphological and microscopic examination of herbs, Evaluation of drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids,phenoliccompounds).Plantgenebanks,CultivationofPlantsand theirvalueadded processing / storage / quality control for use in herbal formulations, Introductory knowledge of Tissue culture and Micro propagation of some medicinal plants (*Withania somnifera*, neem and tulsi),

Suggested Readings

1. Agarwal, P., Shashi, Alok., Fatima, A. and Verma, A. (2013). Current scenario ofHerbal Technology worldwide: An overview. *Int J Pharm Sci Res*; 4(11):4105-17.
2. Arber, Agnes. (1999). Herbal Plants and Drugs. Mangal Deep Publications,Jaipur.
3. Varzakas, T., Zakynthinos, G, and Francis Verpoort, F. (2016). Plant Food Residues as a Source of Nutraceuticals and Functional Foods. Foods 5 : 88.
4. Aburjai, T. and Natsheh, F.M. (2003). Plants Used in Cosmetics. Phytotherapy Research 17 :987-1000.
5. Patri, F. and Silano, V. (2002). Plants in cosmetics: Plants and plant preparations usedas ingredients for cosmetic products - Volume 1. ISBN 978-92-871-8474-0, pp218.
6. AYUSH (www.indianmedicine.nic.in). *About the systems—An overview of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy.* New Delhi: Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry and Family Welfare, Government ofIndia.
7. Evans, W.C. (2009): Trease and Evans PHARMACOGNOSY. 16th Edition,SAUNDERS/ Elsevier.
8. Sivarajan,V.V.andIndia,B.(1994).AyurvedicDrugsandTheirPlantSources..*Oxford &IBH Publishing Company*, 1994 - Herbs - 570 pages.
9. Miller,L.andMiller,B.(2017).Ayurveda&Aromatherapy:TheEarthEssentialGuideto Ancient Wisdom and Modern Healing. *Motilal Banarsidass,;Fourth edition.*
10. Kokate, C.K. (2003). Practical Pharmacognosy. Vallabh Prakashan,Pune.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Develop their understanding on HerbalTechnology and principle of cultivation of herbalproducts.	**PO1**
CO2	List the major herbs, their botanical name and chemicalconstituents and evaluate the drug adulteration through the biologicaltesting	**PO4**
CO3	Develop the skills for cultivation of plants and their value added processing / storage / qualitycontrol	**PO5**
CO4	Knowledge about tissue culture and micropropagation	**PO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 109A	**Herbal Technology**	3			1	1									2

1=weakly mapped 2= moderately mapped 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	**3**													
CO2				3										
CO3					3									
CO4	3			3										
1=lightly mapped 2= moderately mapped 3=strongly mapped														

SEMESTER II

BSCH102A	Physical Chemistry-I	L	T	P	C
Version 3.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Chemistry				
Co-requisites	--				

Course Objectives

1. To be able to differentiate between the three states of matter on the basis of their properties.
2. To learn about various gas laws and equations (ideal and Van Der Waals)
3. To understand various aspects related to ionic equilibrium.
4. To develop an understanding of arrangement of atoms/ions in crystalline solids.

Course Outcomes

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

CO1. Understand Fundamental Concepts of gaseous law, equilibrium and its application to various systems.

CO2. Analyze the behavior of real gases using the Van der Waals equation.

CO3. Apply the gas laws (e.g., Boyle's law, Charles's law, Avogadro's law) to solve problems related to gas properties and behavior.

CO4. Apply mathematical and conceptual problem-solving skills to solve complex physical chemistry problems.

CO5. Develop critical thinking skills to analyze and evaluate experimental results and propose solutions

Catalogue Description

This course imparts the basic concepts of states of matter and ionic equilibrium. It enables the students to learn about the various properties which are unique to solids, liquids and gases. The course will help to explain several gas laws, and equation with the help of kinetic theory of gases. The course introduces the basic concepts about ionic equilibrium, namely, ionisation, hydrolysis, titrations buffer solutions, acid-base titrations, etc. stacks, queues, lists, trees and graphs. It also discusses about the structure and arrangement at the atomic level in the liquid state and the solid state.

Course Content

Unit I: 15 Lectures

Gaseous state

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: 15 Lectures

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.

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 III: 15 Lectures

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: **15 Lectures**

Solid State

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Millerindices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitativeidea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-raydiffraction, 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.

Text Books

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).

Reference Books/Materials

1. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
2. G. M. Barrow, Tata McGraw Hill (Fifth Edition) (2007)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program**
CO1	Understand Fundamental Concepts of gaseous law,	**PO1**
CO2	Analyze the behavior of real gases using the Van der Waals	**PSO3**
CO3	Apply the gas laws (e.g., Boyle's law, Charles's law,	**PO1**
CO4	Apply mathematical and conceptual problem-solving skills to	**PSO3**
CO5	Develop critical thinking skills to analyze and evaluate	**PO2**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 102A	Physical Chemistry-I	3	5		1	2								4	

1=weakly mapped 2= moderately mapped 3=strongly mapped

Programme and Course Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO 2	PSO 3	PSO4
CO1	**3**													
CO2													**3**	
CO3	**3**													
CO4		**3**												
CO5				**3**										
CO6												**3**		

1=lightly mapped 2= moderately mapped 3=strongly mapped

SCH152A	Physical Chemistry-I Practicals	L	T	P	C
Version 3.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of Chemistry				
Co-requisites	--				

Course Objectives

1. To be able to use simple glass instruments like viscometer and stalagmometer.
2. To calculate the values of surface tension and viscosity from the relevant experimental readings.
3. To use a pH-meter and measure the pH value of any given solution.
4. To understand the theory of pH-metric titrations.

Course Outcomes

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

CO1. Understand the working principles of instruments used in surface tension, viscosity, and pHmetry experiments.

CO2. Apply appropriate calculations and statistical analysis to quantify and report uncertainties in the measurements.

CO3.Analyze experimental data and interpret results based on theoretical concepts.

CO4. Evaluate and quantify uncertainties associated with measurements and calculations.

CO5.Create well-structured laboratory reports that include experimental procedures, observations, and results for surface tension, viscosity, and pHmetry experiments.

Catalog Description **15 lecture**

This course imparts the basic concepts of physical chemistry experiments. It enables the students to learn the usage of simple instruments like viscometer and stalagmometer. The course will explain the working theory behind a pH-meter, and how to carry out measurements and pH-metric titrations.The course introduces the basic concepts about buffer solutions and the students will observe the resistance in pH change of buffer solutions.

Course Content

1. Surface tensionmeasurements.

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

b. Study the variation of surface tension of detergent solutions withconcentration.

2. Viscosity measurements using Ostwald'sviscometer.

a. Determinationofviscosityofaqueoussolutionsof(i)polymer(ii)ethanoland(iii)sugaratroom temperature.

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

3. pHmetry

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

b. Preparation of buffer solutions of differentpH

i. Sodium acetate-acetic acid

ii. Ammonium chloride-ammoniumhydroxide

c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strongbase.

d. Determination of dissociation constant of a weakacid.

Recommended text books/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 Intenational (2001)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand working principles of instruments used in surface tension, viscosity, and pHmetry experiments.	**PO4**
CO2	Apply appropriate calculations and statistical analysis to quantify and report uncertainties in the measurements.	**PO5**
CO3	Analyze experimental data and interpret results based on theoretical concepts.	**PSO1**
CO4	Evaluate and quantify uncertainties associated with measurements and calculations.	**PO2**
CO5	Create well-structured laboratory reports that include experimental procedures, observations, and results for surface tension, viscosity, and pHmetry experiments.	**PO1**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 201A	Physical Chemistry-II	3	2		1	2						3			

1=weakly mapped 2= moderately mapped 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1				**3**										
CO2					**3**									
CO3											**3**			
CO4		**3**												
CO5	**3**													
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH108A	Organic Chemistry-II	L	T	P	C
Version 3.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of reaction mechanism				
Co-requisites	--				

Course Objectives

1. Understanding of the organic functional groups, which include halogenated hydrocarbons and oxygen containing functional groups and their reactivity patterns.
2. The detailed reactions mechanistic pathways for each functional group will be discussed to unravel the spectrum of organic chemistry and the extent of organic transformations.

Course Outcomes

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

CO1. Understand preparation, properties and reactions of haloalkanes and haloarenes

CO2. Understand preparation, properties and reactions of alcohols and phenols

CO3. Learn the chemistry of named reactions related to carbonyl compounds.

CO4. Understand preparation, properties and reactions of Carboxylic acids.

CO5. Apply the knowledge of synthetic chemistry learnt in this course to do functional group transformations.

CO6. Propose possible mechanisms for any relevant reaction.

Catalog Description

This course contains chemistry of halogenated compounds, alcohols and phenols. Course also contributes various name reactions of carbonyl compounds including details of carboxylic acids.

Course Content

UNIT I

Chemistry of Halogenated Hydrocarbons 15 Lectures

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_N^I mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

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 II

Alcohols, Phenols, Ethers and Epoxides 15 Lectures

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction;Preparationandpropertiesofglycols:Oxidationbyperiodicacidandleadtetraacetate, Pinacol-Pinacolonerearrangement.

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 $LiAlH_4$

UNIT III

Carbonyl Compounds 15 Lectures

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 IV

Carboxylic Acids and their Derivatives 15 Lectures

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric,

citric,maleicandfumaricacids;Preparationandreactionsofacidchlorides,anhydrides,estersand 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 Curtiusrearrangement.

Sulphur containing compounds

Preparation and reactions of thiols, thioethers and sulphonic acids.

Recommended Books/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, New Delhi.

4 Morrison R. T. and Boyd R. N. Organic Chemistry, Sixth Edition Prentice Hall India,2003.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand preparation, properties and reactions of haloalkanes and haloarenes	**PO1**
CO2	Understand preparation, properties and reactions of alcohols and phenols	**PO5**
CO3	Learning of name reactions related to carbonyl compounds.	**PO5**
CO4	Understand preparation, properties and reactions of Carboxylic acids.	**PO5**
CO5	Use the synthetic chemistry learnt in this course to do functional group transformations.	**PO1 &PO3**
CO6	To propose possible mechanisms for any relevant reaction.	**PO2**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team.	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 108A	ORGANIC CHEMISTRY-II	3	3		3	3						3		3	

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO 2	PSO 3	PSO4
CO1	3													
CO2					3									
CO3					3									
CO4					3									
CO5	3		3											
CO6		3												

1=lightly mapped 2= moderately mapped 3=strongly mapped

BSCH158A	Organic Chemistry-II Practicals	L	T	P	C
Version 3.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics knowledge of organic compounds				
Co-requisites	--				

Course Objectives

1. To enable the student for hands on learning by experiments.
2. To generate confidence among students to perform reactions or analysis.

Course Outcomes

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

CO1. Understand the identification of elements and functional group of unknown organic compounds by sequential procedures.

CO2. Understand the organic synthesis by changing one compound into another.

CO3. Analyze the difference between green synthesis and conventional synthesis.

CO4. Learn about purification of substances.

CO5. Learn about the environment safety at the time of performing experiment.

Catalog Description

This course contains identification of elements and functional group of unknown organic compounds by sequential procedures. Acetylation, bromination, nitration, green synthesis, oxidation and reduction reactions are the major component of the syllabus.

Course Content **30 lecture**

(List of experiments given are suggestive. One experiment from each group to be demonstrated)

1.Identification of elements (N, S, and halogen) and Functional group tests for alcohols, phenols, carbonyl, carboxylic acid and amine group of compounds.

2. Organic preparations:

i. Acetylationofoneofthefollowingcompounds:amines(aniline,*o*-,*m*-,*p*-toluidinesand*o*-,*m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method: (Using conventional method.and Using green chemistryapproach)

ii. Benzolyationofoneoftheamines(aniline,*o*-,*m*-,*p*-toluidinesand*o*-,*m*-,*p*-anisidine)andone of the phenols (*β*-naphthol, resorcinol, *p*-cresol) by Schotten-Baumannreaction.

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

iv. Bromination (anyone)

a. Acetanilide by conventionalmethods

b. Acetanilide using green approach (Bromate-bromidemethod)

v. Nitration: (anyone)

a. Acetanilide/nitrobenzene by conventionalmethod

b. Salicylic acid by green approach (using ceric ammoniumnitrate).

vi. Selective reduction of *meta*dinitrobenzene to *m*-nitroaniline.
vii. Reduction of *p*-nitrobenzaldehyde by sodiumborohydride.
viii. Hydrolysis of amides andesters.
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 phthalicacid).
xi. Aldol condensation with either conventional or greenmethod.
xii. Benzil-Benzilic acidrearrangement.
Collected solid samples may be used for recrystallization, melting point and TLC.

Recommended Books/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.*ComprehensivePracticalOrganicChemistry:Preparationand Quantitative Analysis,* University Press(2000)
4 Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press(2000).(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Components	**Conduct of Experiment**	**Lab Record/Quizzes / Viva-Voce**	**Attendance**	**End Term PracticalExamination**
Weightage (%)	**20**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the identification of elements and functional group of unknown organic compounds by sequential procedures.	**PO4**
CO2	Understand the organic synthesis by changing one compound into another.	**PO6**
CO3	Analyze the difference between green synthesis and conventional synthesis.	**PO7**
CO4	Learn about purification of substances.	**PO4**
CO5	Learn about the environment safety at the time of performing experiment.	**PO7**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 158A	Organic Chemistry-II Practicals				3		3	3				3			3

1=weakly mapped 2= moderately mapped 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**
CO1				**3**										
CO2						**2**								
CO3							**3**					**3**		
CO4				**3**									**3**	
CO5							**5**							
1=lightly mapped 2= moderately mapped 3=strongly mapped														

UCCS155A	Communication Skills	L	T	P	C
Version 3.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives

1. Understand the basics of Grammar to improve written and oral communication skills.
2. Understand the correct form of English with proficiency
3. Improve student's personality and enhance their self-confidence.
4. Improve professional communication.
5. Enhance academic writing skills.

Course Outcomes

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

CO1. Remember the components and principles of effective communication.

CO2. Understand the factors that influence communication, such as culture, gender, and nonverbal cues.

CO3. Apply effective communication techniques in different scenarios, such as presentations, group discussions, and written reports.

CO4. Analyze the effectiveness of various communication techniques and strategies in different contexts.

CO5. Evaluate the effectiveness of communication strategies in achieving desired outcomes.

CO6. Create coherent and persuasive written documents, such as reports or essays.

Catalog Description

This learning program with its practice-based learning tasks will facilitate the learners to enhance their communication skills in a modern and globalized context, enhance their linguistic and communicative competence and hone their interpersonal skills.

Course Content

UNIT I **6 Lectures**

Introduction to Communication: Importance of Communication Skills, Meaning, Forms & Types of Communication; Process of Communication; Principles of Effective Communication/7Cs, Barriers in Communication (Interpersonal, Intrapersonal and Organizational).

UNIT II **6 Lectures**

Academic Writing: Précis (Summary – Abstract – Synopsis – Paraphrase – Précis: Methods), Letter & Résumé (Letter Structure & Elements – Types of letter: Application & Cover - Acknowledgement – Recommendation – Appreciation – Acceptance – Apology – Complaint –Inquiry).Writing a proposal and synopsis. Structure of a research paper. Citations and plagiarism.

UNIT III **6 Lectures**

Technology-Enabled Communication: Using technology in communication tasks, E-mails, tools for constructing messages, Computer tools for gathering and collecting information; Different virtual medium of communication.

UNIT IV **6 Lectures**

Building Vocabulary: Word Formation (by adding suffixes and prefixes); Common Errors; Words Often Confused; One word substitution, Homonyms and Homophones; Antonyms &Synonyms, Phrasal Verbs, Idioms & Proverbs (25 each); Commonly used foreign words(15 in number);

UNIT V **6 Lectures**

Personality Development: Etiquettes& Manners; Attitude, Self-esteem & Self-reliance; Public Speaking; Work habits (punctuality, prioritizing work, bringing solution to problems), Body Language: Posture, Gesture, Eye Contact, Facial Expressions; Presentation Skills/ Techniques.

Textbook [TB]:

Kumar, Sanjay and Pushplata.*Communication Skills*.Oxford University Press, 2015.

Reference Books/Materials

1. Mitra, Barun K. *Personality Development and Soft Skills*. Oxford University Press, 2012.
2. Tickoo, M.L., A. E.Subramanian and P.R.Subramaniam.*Intermediate Grammar, Usage and Composition.* Orient Blackswan, 1976.
3. Bhaskar, W.W.S., AND Prabhu, NS., " English Through Reading", Publisher: MacMillan,1978
4. Business Correspondence and Report Writing" -Sharma, R.C. and Mohan K. Publisher: Tata McGraw Hill1994
5. Communications in Tourism & Hospitality- Lynn Van Der Wagen, Publisher: HospitalityPress
6. Business Communication-K.K.Sinha
7. Essentials of Business Communication By Marey Ellen Guffey, Publisher: ThompsonPress
8. How to win Friends and Influence People By Dale Carnegie, Publisher: Pocket Books
9. Basic Business Communication By Lesikar&Flatley, Publisher Tata McGraw Hills
10. Body Language By Allan Pease, Publisher SheldonPress

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remember the components and principles of effective communication.	**PO8**
CO2	Understand the factors that influence communication, such as culture, gender, and nonverbal cues.	**PO8**
CO3	Apply effective communication techniques in different scenarios, such as presentations, group discussions, and written reports.	**PO10**
CO4	Analyze the effectiveness of various communication techniques and strategies in different contexts.	**PO8**
CO5	Evaluate the effectiveness of communication strategies in achieving desired outcomes.	**PO8. PO5**
CO6	Create coherent and persuasive written documents, such as reports or essays.	**PO5**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
SHEL 155A	Communication Skills					6			1, 2, 4, 5		3				

1=weakly mapped 2= moderately mapped 3=strongly mapped

Programme and Course Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO 2	PSO 3	PSO4
CO1								**3**						
CO2								**3**						
CO3										**3**				
CO4								**3**						
CO5					**3**			**3**						
CO6					**3**									

1=lightly mapped 2= moderately mapped 3=strongly mapped

BSCH110A	Intellectual property right (IPR) and business skills for chemists	L	T	P	C
Version 1.0		2	0	0	2
Total Contact Hours	30				
Pre-requisites/Exposure	NA				
Co-requisites	--				

Course Objectives

1. To aware the students about the Intellectual Property Rights.
2. To familiarize the students with the different types of IP and importance of protecting IP.
3. To give an understanding of the IP laws in International prospective.
4. To explain the key business concepts and current challenges and opportunities in the market.

Course Outcomes

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

CO1. Remember fundamental concepts and principles of intellectual property rights (IPR) related to chemistry.

CO2. Understand the importance of IPR in promoting innovation, protecting inventions, and fostering business growth.

CO3. Apply strategies and techniques for conducting intellectual property searches, prior art analysis, and patent landscape assessments.

CO4. Analyze and evaluate real-world case studies and scenarios involving intellectual property rights in the chemical industry.

CO5. Evaluate the competitive landscape and identify opportunities for leveraging intellectual property assets to gain a competitive advantage in the chemical industry.

CO6. Create a comprehensive intellectual property protection plan for a hypothetical chemical invention or innovation.

Catalog Description

This Intellectual property has increasingly assumed a vital role with the rapid pace of technological, scientific and medical innovation that we are witnessing today. Moreover, changes in the global economic environment have influenced the development of business models where intellectual property is a central element establishing value and potential growth. In India several new legislations for the protection of intellectual property rights (IPRs) have been passed to meet the international obligations under the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). Intellectual property has therefore grown into one of the world's biggest and fastest-growing fields of law thereby necessitating the demand for IP professionals well versed in this area to deal with (IPRs) across the national and intern
The study of different International agreements as Word Trade Organization (WTO), Paris Convention helps in understanding various laws in India Licensing and technology transfer.

The application of Chemistry in Industry makes clear the current challenges and opportunities for the chemistry-using industries, its role in India and global economies and Financial aspects of business with case studies for better knowledge.

Course Content

UNIT I **7 Lectures**

Introduction to Intellectual Property:
Historical Perspective, Different Types of IP, Importance of protecting IP.
Copyrights
Introduction, How to obtain, Differences from Patents.
Trade Marks
Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.
Patents Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

UNIT II **8 Lectures**

Geographical Indications, Definition, rules for registration, prevention of illegal exploitation, importance to India.Industrial Designs, Definition, How to obtain, features, International design registration.Layout design of integrated circuits, Circuit Boards, Integrated Chips, Importance for electronic industry.Trade Secrets.Introduction, Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.

UNIT III **7 Lectures**

Different International agreements
1. World Trade Organization (WTO):
(i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement
(ii) General Agreement on Trade related Services (GATS)
(iii) Madrid Protocol
(iv) Berne Convention
(v) Budapest Treaty
2.Paris Convention
WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity IP Infringement issue and enforcement – Role of Judiciary, Role of law enforcement agencies – Police, Customs etc.

UNIT IV **8 Lectures**

Business Basics

Key business concepts: Business plans, market need, project management and routes to market. Chemistry in Industry, Current challenges and opportunities for the chemistry-using industries, role of chemistry in India and global economies. Financial aspects Financial aspects of business with case studies.

Textbooks

1. V.K AHUJA, Law Relating to INTELLECTUAL PROPERTY RIGHTS, Lexis Nexis.

Reference Books/Materials

1. Guru, M. & Rao, M.B. Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
2. Ganguli, P. Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw- Hill (2001).
3. Miller, A.R. & Davis, M.H. Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
4. Watal, J. Intellectual property rights in the WTO and developing countries, Oxford University Press, New Delhi.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remember fundamental concepts and principles of intellectual property rights (IPR) related to chemistry.	**PO3,PO10**
CO2	Understand the importance of IPR in promoting innovation, protecting inventions, and fostering business growth.	**PO3,PO5,PO10**
CO3	Apply strategies and techniques for conducting intellectual property searches, prior art analysis, and patent landscape assessments.	**PO3**
CO4	Analyze and evaluate real-world case studies and scenarios involving intellectual property rights in the chemical industry.	**PO3,PO5,PO6,PO10**
CO5	Evaluate the competitive landscape and identify opportunities for leveraging intellectual property assets to gain a competitive advantage in the chemical industry.	**PO3**
CO6	Create a comprehensive intellectual property protection plan for a hypothetical chemical invention or innovation.	**PSO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 110A	Intellectual property right (IPR) and business skills for chemist			2, 5	1	3					2			1	3

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1			**3**							**3**				
CO2			**3**		**3**					**3**				
CO3			**3**											
CO4			**3**		**3**	**3**				**3**				
CO5			**3**											
CO6														**3**
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCS104A	INTRODUCTION TO COMPUTERS AND PROGRAMMING IN PYTHON	L	T	P	C
Version 1.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Advanced of Computer communication				
Co-requisites	--				

Course Objectives

1. Provide an understanding of the role computation can play in solving problems.
2. Master the fundamentals of writing Python scripts.
3. Learn core Python scripting elements such as variables and flow control structures.
4. Discover how to work with lists and sequence data.
5. Position students so that they can compete for projects and excel in subjects with programming components.

Course Outcomes

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

CO1. Remember fundamental concepts in computer science, including programming languages, algorithms, and data structures.

CO2. Understand the purpose and functions of different software and hardware components in a computer system.

CO3. Apply programming concepts and techniques using Python to solve simple to moderate complexity problems.

CO4. Analyze and debug Python programs to identify and resolve errors or issues.

CO5. Evaluate the efficiency and effectiveness of algorithms and data structures used in Python programming.

CO6. Create and implement algorithms and data structures suitable for specific programming scenarios.

Catalog Description

Introduction to Computer and Programming in Python is intended for students with little or no programming experience. It aims to provide students with an understanding of the role computation can play in solving problems and to help students, regardless of their major, feel justifiably confident of their ability to write small programs that allow them to accomplish useful goals. The class will use the Python 3.5 programming language.

Course Content

UNIT I **15 LECTURES**

Introduction to Programming: Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm:Flowchart / Pseudo code with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code

UNIT II **15 LECTURE**

Introduction to Python: The basic elements of python, Branching Programs, Control Structures, Strings and Input, Iteration, String Manipulation, Guess and Check, Approximations, Bisection, Functions, Scoping and Abstraction: Functions and scoping, Specifications, Recursion, Global variables, Modules, Files

UNIT III **15 LECTURE**

Classes and Object: Oriented Programming: Abstract Data Types and Classes, Inheritance, Encapsulation and Information Hiding, Handling Exceptions, Decorators

UNIT IV **15 LECTURE**

Simple Algorithms and Data structures: File Handling, Search Algorithms, Sorting, Algorithms, Hash Tables

TEXTBOOKS:

1. John V Guttag. "Introduction to Computation and Programming Using Python", Prentice Hall of India

Reference Books

1. R. Nageswara Rao, "Core Python Programming", Dreamtech
2. Wesley J. Chun. "Core Python Programming, Second Edition", Prentice Hall
3. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in Python", Wiley
4. Kenneth A. Lambert, "Fundamentals of Python,First Programs", CENGAGE Publication

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remember fundamental concepts in computer science, including programming languages, algorithms, and data structures.	**PO4, PSO1**
CO2	Understand the purpose and functions of different software and hardware components in a computer system.	**PO3**
CO3	Apply programming concepts and techniques using Python to solve simple to moderate complexity problems.	**PO3, PSO3**
CO4	Analyze and debug Python programs to identify and resolve errors or issues.	**PO2**
CO5	Evaluate the efficiency and effectiveness of algorithms and data structures used in Python programming.	**PO4**
CO6	Create and implement algorithms and data structures suitable for specific programming scenarios.	**PO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO 3	PSO4
BSCS 104A	Introduction To Computers And Programming In Python		3	2, 3	5, 6							1		3	

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1				**3**							**3**			
CO2			**3**											
CO3			**3**										**3**	
CO4		**3**												
CO5				**3**										
CO6				**3**										
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCS150A	INTRODUCTION TO COMPUTERS AND PROGRAMMING IN PYTHON LAB	L	T	P	C
Version 1.0		0	0	2	1
Total Contact Hours	15				
Pre-requisites/Exposure	Practical learning				
Co-requisites	--				

Course Objectives

2. Master the fundamentals of writing Python scripts.
3. Learn core Python scripting elements such as variables and flow control structures.
4. Discover how to work with lists and sequence data.
5. Position students so that they can compete for projects and excel in subjects with programming components.

Course Outcomes

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

CO1. Remember fundamental concepts and principles of computer programming and software development.

CO2. Understand the purpose and functionality of different software tools and utilities used in Python programming.

CO3. Apply programming concepts and techniques in Python to solve practical problems and implement algorithms.

CO4. Analyze and debug Python programs to identify and resolve errors or issues.

CO5. Evaluate the correctness and functionality of Python programs based on given specifications and requirements.

CO6. Create and integrate various programming concepts and techniques to build comprehensive Python applications.

Course Content **15 lecture**

List of Experiments

1	Develop programs to implement list	**2 lab hours**
2	Develop programs to implement Dictionary	**2 lab hours**
3	Develop programs to implement tuples	**2 lab hours**
4	Develop programs to understand the control structures of python	**2 lab hours**
5	Develop programs to implement function with stress on scoping	**2 lab hours**
6	Develop programs to implement classes and objects	**2 lab hours**
7	Develop programs to implement exception handling.	**2 lab hours**
8	Develop programs to implement linear search and binary search.	**2 lab hours**
9	Develop programs to implement insertion sort	**2 lab hours**
10	Develop programs to implement bubble sort.	**2 lab hours**
11	Develop programs to implement quick sort.	**2 Labs**
12	Develop programs to implement heap sort.	**2 Labs**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Remember fundamental concepts and principles of computer programming and software development.	PO4, PSO1
CO2	Understand the purpose and functionality of different software tools and utilities used in Python programming.	PO3, PSO1
CO3	Apply programming concepts and techniques in Python to solve practical problems and implement algorithms.	PO4
CO4	Analyze and debug Python programs to identify and resolve errors or issues.	PO2
CO5	Evaluate the correctness and functionality of Python programs based on given specifications and requirements.	PSO2
CO6	Create and integrate various programming concepts and techniques to build comprehensive Python applications.	PO5

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCS 150A	Introduction To Computers And Programming In Python Lab		3	2	1,3	3						1, 2	2	3	

1=weakly mapped 2= moderately mapped 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1				**3**							**3**			
CO2			**3**								**3**			
CO3				**3**										
CO4		**3**										**3**		
CO5												**3**		
CO6					**3**									**3**
1=lightly mapped 2= moderately mapped 3=strongly mapped														

SEMESTER III

BSCH201A	**Physical Chemistry-II**	L	T	P	C
Version 3.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Physical Chemistry (Upto class XII)				
Co-requisites	—				

Course Objectives

1. To explain the basic concepts of thermodynamics such as system, state, state postulate, equilibrium, properties, process and cycle
2. To distinguish between Open, Closed and Isolated systems, Microscopic and Macroscopic approaches, Intensive and Extensive properties
3. To define zeroth law of thermodynamics and explain the concept of pressure, temperature, specific volume and temperature scales.
4. To apply the above concepts to solve simple chemistry problems.

Course Outcomes

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

CO1. Remember fundamental concepts in thermodynamics.

CO2. Understand the laws of thermodynamics and their applications in studying chemical systems.

CO3. Apply the concepts learned to solve simple chemistry problems involving thermodynamic processes, including energy transfer, work calculations, and state changes.

CO4. Analyze data from thermodynamic experiments or measurements, and draw conclusions based on thermodynamic principles.

Catalog Description

The topic of thermodynamics helps students in understanding the laws of thermodynamics and concepts. The concept of Partial molar quantities and its attributes relate properties to concentration. The knowledge of dilute solution and its properties helps students in understanding the concept of system, variables, heat, work, and laws of thermodynamics. The concept of heat of reactions and use of equations in calculations of bond energy, enthalpy, etc.enables students to make use of thermodynamics in day to day activities. The understanding of the concept of entropy; reversible, irreversible processes enables them to calculate entropy using 3rd law of thermodynamics. Joule Thompson effects, Gibbs- Helmholtz equation; Maxwell relations.makes a clear scenario of the daily routine appliances utilising the concept of thermodynamics. Four colligative properties: (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure explain the freezing of water, use of pressure cooker, removal of snow using solid carbon dioxide.

Course Content

Unit I: 15 Lectures

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: 15 Lectures

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.

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.

Unit III: 15 Lectures

Third law of thermodynamics Third Law of thermodynamics, residual entropy, calculation of absolute entropy of molecules.**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; inversiontemperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Unit IV: 15 Lectures

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.

Text Books

1 Atkins P. and De Paula, J. Physical Chemistry Tenth Ed., OUP, 2014. 2
2 Castellan, G. W. Physical Chemistry 4th Ed., Narosa, 2004.

Reference Books/Materials

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

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remember fundamental concepts in thermodynamics	**PO4**
CO2	Understand the laws of thermodynamics and their applications in studying chemical systems.	**PSO1**
CO3	Apply the concepts learned to solve simple chemistry problems involving thermodynamic processes, including energy transfer, work calculations, and state changes.	**PO2, PSO3**
CO4	Analyze data from thermodynamic experiments or measurements, and draw conclusions based on thermodynamic principles.	**PO5**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 201A	Physical Chemistry-II		3		1	4						2		3	

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1				**3**										
CO2											**3**			
CO3		**3**											**3**	
CO4					**3**									
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH251A	Physical Chemistry-II Practicals	L	T	P	C
Version 3.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of Physical Chemistry				
Co-requisites	--				

Course Objectives

. To perform time-bound experiments in order to do kinetic studies.

1. To learn about equilibrium and study it experimentally.
2. To understand physical parameters like, critical solution temperature, and distribution coefficient.
3. To observe the phenomenon of adsorption using activated charcoal.

Course Outcomes

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

CO1. Remember fundamental principles and concepts related to adsorption, kinetics, critical solution temperature, and equilibrium.

CO2. Understand the experimental procedures and techniques used in adsorption, kinetics, critical solution temperature, and equilibrium experiments.

CO3. Apply experimental techniques to perform adsorption experiments and measure adsorption capacities.

CO4. Analyze and interpret experimental data obtained from adsorption, kinetics, critical solution temperature, and equilibrium experiments.

CO5. Evaluate impact and significance of experimental results and findings in advancing the understanding of adsorption, kinetics, critical solution temperature, and equilibrium principles.

CO6. Create strategies and procedures to optimize adsorption capacities, reaction rates, critical solution temperature determinations, and equilibrium measurements.

Catalog Description

This course imparts the basic concepts and protocols of experiments based on distribution method, equilibrium, and chemical kinetics. It enables them to experimentally work out physical parameters, like, critical solution temperature, and partition coefficient. It also discusses about the theory of adsorption and method to confirm Freundlich and Langmuir isotherm.

Course Content **30 lecture**

List of Experiments

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^- → I_3^- (aq)

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

3. Study the kinetics of the following reactions.
   a. Acid hydrolysis of methyl acetate with hydrochloric acid.
   b. Saponification of ethyl acetate.
4. Adsorption: Verification of Freundlich and Langmuir isotherms for adsorption of acetic acid and selected organic dye(s) on activated charcoal.

(Use of calorimeter for calculation of heat of reactions may be demonstrated)

Practical Books

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).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program**
CO1	Remember fundamental principles and concepts related to adsorption, kinetics, critical solution temperature, and	**PO1**
CO2	Understand the experimental procedures and techniques used in adsorption, kinetics, critical solution temperature, and	**PO5**
CO3	Apply experimental techniques to perform adsorption experiments and measure adsorption capacities.	**PO2**
CO4	Analyze and interpret experimental data obtained from adsorption, kinetics, critical solution temperature, and	**PO4**
CO5	Evaluate impact and significance of experimental results and findings in advancing the understanding of adsorption, kinetics,	**PO1**
CO6	Create strategies and procedures to optimize adsorption capacities, reaction rates, critical solution temperature	**PO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH251A	Physical Chemistry-II Practicals	2	2		1	3	2	2			1	3	3	2	

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	**3**													
CO2					**3**									
CO3		**3**												
CO4				**3**										
CO5	**3**													
CO6				**3**										
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH203A	ORGANIC CHEMISTRY-III	L	T	P	C
Version 3.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of organic chemistry and reaction mechanism				
Co-requisites	--				

Course Objectives

1. To enable the students to understand Nitrogen containing functional groups and their reactions.
2. To familiarize the students with poly nuclear hydrocarbons and their reactions.
3. To enable the students to understand Heterocyclic compounds and their reactions.
4. Classification, structure, mechanism of reactions of few selected alkaloids and terpenes.

Course Outcomes

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

CO1. Remember the methods used for the synthesis of amines and heterocycles.

CO2. Understand the structures, stability, and properties of amines, polynuclear hydrocarbons, and five-membered and six-membered heterocycles.

CO3. Apply the methods of synthesis to prepare amines and heterocycles.

CO4. Analyze and compare the reactivity and properties of different types of amines and heterocycles.

CO5. Evaluate the importance and limitations of different synthetic methods for heterocycles.

CO6. Create synthetic routes for the preparation of complex heterocyclic compounds.

Catalog Description

This course contains structure, stability, methods of synthesis and reactions of amine and their derivatives. The importance of polynuclear hydrocarbon discussed with applications. The course will apprise students about the synthesis, reactions and mechanism of substitution reactions of five membered and six membered heterocycles like furan, pyrrole, pyridine, thiophene and indole etc. This course also comprise of some natural products as alkaloids and terpenes.

Course Content

UNIT I

Nitrogen Containing Functional Groups **15 Lectures**

Preparation and important reactions of nitro and compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann- elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid. Diazonium salts: Preparation and syntheticapplications.

UNIT II

Polynuclear Hydrocarbons **15 Lectures**

Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.

UNIT III

Heterocyclic Compounds **15 Lectures**

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containingoneheteroatom;Synthesis,reactionsandmechanismofsubstitutionreactionsofFuran, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler- Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction Derivatives of furan: Furfural and furoicacid.

UNIT IV

Alkaloids **15 Lectures**

Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

Terpenes

Occurrence, classification, isoprenerule; Elucidationof structure and synthesis of Citral, Neraland α-terpineol.

Recommended Text Books/references:

1. Morrison, R. T., Boyd, R. N., Bhatterjee, S.K., Organic Chemistry, 7thEdn., Pearson.
2. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Welly &Sons (1976).
3. Solomons, T.W., Fryhle Craig, *Organic Chemistry*, John Wiley & Sons, Inc(2009).
4. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
5. Kalsi, P. S. *Organic reactions and their mechanisms,* New Age Science(2010).
6. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* Oxford UniversityPress Inc., New York(2001).
7. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan(2010).
8. Bansal R. K. *Heterocyclic Chemistry: Syntheses, Reactions and Mechanisms*, New Age, Third Edition (1999).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remember the methods used for the synthesis of amines and heterocycles.	**PO1**
CO2	Understand the structures, stability, and properties of amines, polynuclear hydrocarbons, and five-membered and six-membered heterocycles.	**PO3**
CO3	Apply the methods of synthesis to prepare amines and heterocycles.	**PO3 & PO2**
CO4	Analyze and compare the reactivity and properties of different types of amines and heterocycles.	**PO6**
CO5	Evaluate the importance and limitations of different synthetic methods for heterocycles.	**PO1**
CO6	Create synthetic routes for the preparation of complex heterocyclic compounds.	**PO1**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 203A	ORGANIC CHEMISTRY-III	2	3	3			3							3	3

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	**3**													
CO2			**3**											
CO3		**3**	**3**											
CO4						**3**								
CO5	**3**													
CO6	**3**													
1=lightly mapped				2= moderately mapped						3=strongly mapped				

BSCH253A	ORGANIC CHEMISTRY-III Practicals	L	T	P	C
Version 3.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics knowledge of organic compounds				
Co-requisites	--				

Course Objectives

1. To enable the student for hands on learning by experiments.
2. To generate confidence among students to perform reactions or analysis.

Course Outcomes

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

CO1. Remember principles and techniques of qualitative analysis.

CO2. Understand the theory and principles of spectroscopy.

CO3. Apply the qualitative analysis techniques to identify functional groups.

CO4. Analyze results of qualitative analysis, spectroscopic studies.

CO5. Evaluate the accuracy of qualitative analysis, synthesis and yield of organic compounds.

CO6. Create a systematic qualitative analysis scheme for the identification of unknown organic compounds.

Catalog Description

This course gives idea about Qualitative analysis of unknown organic compounds by simple and spectroscopic methods. The preparation of Methyl Orange and extraction of caffeine are some innovative approach of this syllabus. This syllabus also provides exposure towards analysis of carbohydrates.

Course Content **30 lecture**

1. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols,etc.
2. Identification of functional groups of simple organic compounds by IR spectroscopy andNMR spectroscopy (IR and NMR of simple organic compounds may be done wherever facilities are available, otherwise sample spectra may be provided for simple organic compounds like Ethanol, Aniline, Phenol, acetic acid, other simple aldehydes, carboxylic acid, etc., for identification of functional groups. References from standard spectroscopy books may also be taken for such purpose for enhancing students understanding andskill).
3. Preparation of methyl orange.
4. Extraction of caffeine from tealeaves.
5. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars usingsimple labprocedures.

Recommended Books/References:

1. Vogel, A.I. *Quantitative Organic Analysis,* Part 3, Pearson(2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education(2009)
3. Furniss,B.S.;Hannaford,A.J.;Smith,P.W.G.;Tatchell,A.R.*PracticalOrganicChemistry,5th Ed.,* Pearson(2012)
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press(2000).
5. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press(2000).

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Remember principles and techniques of qualitative analysis.	PO2
CO2	Understand the theory and principles of spectroscopy.	PO2
CO3	Apply the qualitative analysis techniques to identify functional groups.	PO1
CO4	Analyze results of qualitative analysis, spectroscopic studies.	PO1
CO5	Evaluate the accuracy of qualitative analysis, synthesis and yield of organic compounds.	PO1 &PO4
CO6	Create a systematic qualitative analysis scheme for the identification of unknown organic compounds.	PO7

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH253A	ORGANIC CHEMISTRY-III Practicals	3	3		3			3				3	3		

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1		**3**												
CO2		**3**												
CO3	**3**													
CO4	**3**													
CO5	**3**			**3**										
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH205A	Analytical Techniques of Chemistry	L	T	P	C
Version 2.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Analytics techniques				
Co-requisites	--				

Course Objectives

1. Familiarize with fundamental of analytical chemistry.
2. To establish an appreciation of the role of chemistry in quantitative analysis.
3. To provide experience in some scientific methods employed in analytical chemistry.
4. To develop some understanding of the professional and safety responsibilities residing in working on chemical analysis.

Course Outcomes

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

CO1. Know about the principles and applications of modern chemical instrumentation, experimental design, and data analysis.

CO2. Acquire the knowledge of the underlying chemical and physical of instrumental methods of analysis, including electronic and vibrational spectroscopy, UV-Visible spectroscopy, and electro-analytical techniques.

CO3. Enable students to communicate scientific information clearly and accurately, both in oral and in written forms and apply the concepts to analyze data

CO4. Idea about the composition of written laboratory reports that summarize experimental procedures and the accurately present and interpret data.

CO5. Learn to work with others as part of a team to solve scientific problems

CO6. Interpret results of different gravimetric analysis methods

Catalog Description

This course gives an introduction to analytical chemistry and an overview of important analytical methods and their range of application within detection of inorganic and organic compounds. Important analytical quantitative techniques from classical methods, electrochemical methods, spectrochemical / spectrophotometric methods, and separation techniques are reviewed. As a part of this course, a project work is also to be carried out; relevant topics will be announced at semester start. There will be an excursion at the end of the semester.

Course Content

UNIT I **15 Lectures**

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 **15 Lectures**

Spectroscopy:

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

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

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 III **15 Lectures**

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 pKa values.

UNIT IV **15 Lecture**

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.

Recommended Books/Reference Books:

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, Saunder College Publications, (1998).
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 9.Skoog D.A., Holler F.J., Nieman T.A., Principles of instrumental analysis, 5th Edn., Brooks & Cole (1997).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Know about the principles and applications of modern chemical instrumentation, experimental design, and data analysis.	**PO4**
CO2	Acquire the knowledge of the underlying chemical and physical of instrumental methods of analysis, including electronic and vibrational spectroscopy, UV-Visible spectroscopy, and electro-analytical techniques.	**PO5**
CO3	Enable the students how to communicate scientific information clearly and accurately, both in oral and in written forms.	**PO6**
CO4	Idea about the composition of written laboratory reports that summarize experimental procedures and the accurately present and interpret data.	**PO4**
CO5	Learn to work with others as part of a team to solve scientific problems.	**PO6**
CO6	Interpret different gravimetric analysis methods	**PO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 205A	Analytical Techniques of Chemistry				3	3	3					2	2	3	

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1				**3**										
CO2					**3**									
CO3						**3**								
CO4				**3**										
CO5						**3**								
CO6				3										
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH255A	Analytical Techniques of Chemistry Practicals	L	T	P	C
Version 2.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of chromatography and solvent extraction				
Co-requisites	--				

Course Objectives

1. To introduce some analytical techniques like flame photometer, infra-red spectrophotometer
2. To learn about determination of water quality parameters like COD, BOD and DO.
3. To analyse the composition of soil.
4. To learn about qualitative analysis of metal ions from binary mixture.
5. Performing risk assessment of chemical experiments and chemical analytical activity

Course Outcomes

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

CO1. Remember fundamental principles and concepts of analytical chemistry.

CO2. Understand the working principles and theories of analytical techniques.

CO3. Apply appropriate analytical technique and knowledge of instrument operation

CO4. Analyze experimental data obtained from chemical analyses using appropriate statistical tools.

CO5. Evaluate the reliability and validity of analytical results obtained from various techniques.

CO6. Creat new analytical methods or protocols for specific applications.

Catalog Description

This course covers some simple methods for determination water quality parameter like COD, BOD, and DO, major ions present in soil and aerated drinks. The course also gives hand on experience of flame photometer, chromatography and spectrophotometry techniques.

Course Content **30 lecture**

(Recommended to carry out at least two experiments from each section)

I. 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. Solvent Extractions:

i. To separate a mixture of Ni^{2+} & 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.

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

III. Analysis of soil:

i. Determination of pH of soil.

ii. Total soluble salt

iii. Estimation of calcium, magnesium, phosphate, nitrate

IV. Ionexchange:

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.

V. 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.

Recommended text books/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, NewYork, 1974.

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remember fundamental principles and concepts of analytical chemistry.	**PO4**
CO2	Understand the working principles and theories of analytical techniques.	**PO7**
CO3	Apply appropriate analytical technique and knowledge of instrument operation	**PO5**
CO4	Analyze experimental data obtained from chemical analyses using appropriate statistical tools.	**PO5**
CO5	Evaluate the reliability and validity of analytical results obtained from various techniques.	**PO5**
CO6	Creat new analytical methods or protocols for specific applications.	**PO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 255A	Analytical Techniques of Chemistry Practicals		4		1	6		3				2	3	5	

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1				**3**										
CO2							**3**							
CO3					**3**									
CO4					**3**									
CO5					**3**									
CO6				**3**										
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCS109A	Data Analysis and Visualization	L	T	P	C
Version 1.0		2	-	-	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of Python				
Co-requisites	--				

Course Objectives

The objective of this course is to teach students the concepts of Python Programming Language with Libraries.

Course Outcomes

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

CO1. Remember the features and characteristics of different Python libraries and modules.

CO2. Understand fundamental concepts and syntax of the Python programming language.

CO3. Apply Python programming concepts to solve simple programming problems.

CO4. Analyze data structures and algorithms to optimize code efficiency and performance.

CO5. Evaluate the effectiveness and suitability of different libraries for specific programming tasks.

CO6. Create Python programs to solve real-world problems

Catalog Description

Data Analysis with Python is for everyone who would like to create meaningful insight out of the data with the power of Numpy, Pandas, Matplotlib& Seaborn. The course has the right recipe to equip student with the right set of skill to ingest, clean, merge, manipulate, transform and finally visualize the data to create the meaning out of the data at hand.

Course Content

UNIT – I **8 lecture**

NumPy: Array and vectorized computation: Multidimensional array object. Creating ndarrays, arithmetic with numpy array, basic indexing and slicing, Boolean indexing, transposing array and swapping axes, universal functions, array-oriented programming with arrays, conditional logic as arrays operations, file input and output with array

UNIT -II **7 lecture**

Pandas: Pandas data structure, series, DataFrame, Index Object, Reindexing, dropping entities from an axis, indexing, selection and filtering, integer indexes, arithmetic and data alignment, function application and mapping, soring and ranking, correlation and covariance, unique values, values controls and membership, reading and writing data in text format

UNIT -III **8 lecture**

Visualization with Matplotlib: Figures and subplots, colors, markers, line style, ticks, labels, legends, annotation and drawing on sublots, matplotlib configuration

UNIT -IV **7 lecture**

Plotting with pandas and seaborn: line plots, bar plots, histogram, density plots, scatter and point plots, facet grids and categorical data

Textbooks

1.Fabio Nelli, Python Data Analytics 2nd Edition, Apress.

Reference Books/Materials

1. Python for Data Analysis: A Complete Beginner Guide for Python basics, Numpy, Pandas, Seaborn, Bokeh and Matplotlib for Data Analysis, AI Publishing LLC.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Remember the features and characteristics of different Python libraries and modules.	PO2
CO2	Understand fundamental concepts and syntax of the Python programming language.	PO3
CO3	Apply Python programming concepts to solve simple programming problems.	PO4
CO4	Analyze data structures and algorithms to optimize code efficiency and performance.	PO2
CO5	Evaluate the effectiveness and suitability of different libraries for specific programming tasks.	PO3
CO6	Create Python programs to solve real-world problems	PO4

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCS 109A	Data Analysis and Visualization		3	2	3							3		3	

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1		**3**												
CO2			**3**											
CO3				**3**										
CO4		**3**												
CO5			**3**											
CO6				**3**										
1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCS159A	Data Analysis and Visualization Lab	L	T	P	C
Version 1.0		-	-	2	1
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of Python				
Co-requisites	--				

Course Objectives

The objective of this course is to teach students the concepts of Python Programming Language with Libraries.

Course Outcomes

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

CO1. Practical understanding of data analysis with Python package like NumPy and Pandas.

CO2. Implementation of visualization tool (matplotlib and seaborn) so that one will be able to visualize and make correct decision based on the data.

CO3. To practice with real life data to feel confident of the topic and be able to ready to work on data analysis project or interview.

Catalog Description

This course complements ETCS109A. It enables them to write algorithms/programs for implementing python libraries such as NumPy, Pandas, Seaborn etc. The list of experiments helps organizing the data in variety of ways using python and to solve the given problem efficiently.

Course Content

The list of experiments will be based upon syllabus of ETCS109A.

Textbooks

1.Fabio Nelli, Python Data Analytics 2nd Edition, Apress.

Reference Books/Materials

1. Python for Data Analysis: A Complete Beginner Guide for Python basics, Numpy, Pandas, Seaborn, Bokeh and Matplotlib for Data Analysis, AI Publishing LLC.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Theoretical and practical understanding of data analysis with Python package like NumPy and Pandas.	**PO2**
CO2	The knowledge of visualization tool (matplotlib and seaborn) so that one will be able to visualize and make correct decision based on the data.	**PO3**
CO3	To practice with real life data to feel confident of the topic and be able to ready to work on data analysis project or interview,	**PO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCS 159A	Data Analysis and Visualization Lab		3	2	3							3		3	

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PSO1**	**PSO 2**	**PSO 3**	**PSO4**
CO1		**3**												
CO2			**3**											
CO3				**3**										
1=lightly mapped 2= moderately mapped 3=strongly mapped														

SEMESTER IV

BSCH202A	**Physical Chemistry-III**	L	T	P	C
Version 4.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Chemistry				
Co-requisites	--				

Course Objectives

1. To be able to derive Gibbs phase rule and apply it to calculate degrees of freedom.
2. To learn about different terms and equations related to chemical kinetics.
3. To be able to write mathematical expressions for adsorption isotherms.
4. To understand enzyme catalysis and derive relevant equations for Michaelis- Menten mechanism.

Course Outcomes

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

CO1. Understand the concepts of phases and components, and use them to derive Gibbs phase rule.

CO2. Draw phase diagrams of several different types of systems.

CO3. Write the differential and integrated rate laws for zero, first, and second order reactions.

CO4. Explain the kinetics of complex reactions, and work out the related rate laws.

CO5. Learn about different types of catalysis, along with their respective mechanisms.

CO6. Understand the surface phenomenon, adsorption, along with its isotherms.

Catalog Description

The course explains the basic concepts as Phases, components, Gibbs phase rule, Phase diagrams andapplications. It enables the students to understand chemicalkinetics, typeofreactions,determinationofrate,theoriesofreactionrate,steady stateapproximation. It will help the students to work out the order and molecularity. The course will explain the kinetics of complex reactions with the help of suitable examples. It also explains the concept of catalysis, along with enzyme catalysis. Finally, the students will learn about different aspects of adsorption.

Course Content

Unit I: **8 Lectures**

Phase Equilibria

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactiveandreactivesystems;Clausius-Clapeyronequationanditsapplicationstosolid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications.Phasediagramsforsystemsofsolid-liquidequilibriainvolvingeutectic,congruent and incongruent melting points, solid solutions. Three component systems, water-chloroform-acetic acid system, triangular plots. *Binary solutions:* Gibbs-Duhem-Margules equation, its derivationandapplicationstofractionaldistillationofbinarymiscibleliquids(idealandnonideal), azeotropes,leverrule,partialmiscibilityofliquids,CST,misciblepairs,steamdistillation.Nernst distribution law: its derivation andapplications.

Unit II: **12 Lectures**

Chemical Kinetics

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated rate laws for first, second and fractional order reactions, pseudounimolecular reactions, determination of the order, kinetics of complex reactions (limited to first order): (i)Opposing reactions (ii)parallel reactions and (iii)consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Unit III: **12 Lectures**

Catalysis

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts.Enzyme catalysis, Michaelis- Menten mechanism, acid-base catalysis.

Unit IV: **8 Lectures**

Surface chemistry

Physical adsorption, chemisorption, adsorption isotherms (Freundlich, Temkin, Derivation of Langumuiradsorptionisotherms,surfaceareadetermination),BETtheoryofmultilayeradsorption (no derivation), Adsorption insolution.

Text Books

1. AtkinsP.W.andDePaulaJ.,*PhysicalChemistry,(*tenthedition)OxfordUniversityPress, 2014.
2. Castellan, G. W. *Physical Chemistry,* 4th Ed., Narosa ,2004.
3. McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics,* Viva Books, 2004.

Reference Books/Materials

1. Engel, T. & Reid, P. *Physical Chemistry* Third Edition, Prentice-Hall, 2012.
2. Zundhal, S.S. *Chemistry concepts and applications* Cengage India, 2011 6 Ball, D. W. *Physical Chemistry* Cengage India, 2012.
3. Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP, 2009.
4. Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill, 2011.
5. Metz, C. R. *Physical Chemistry 2nd Ed.,* Tata McGraw-Hill,2009.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Quiz/Assignment**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the concepts of phases and components, and use them to derive Gibbs phase rule.	**PO1**
CO2	Draw phase diagrams of several different types of systems.	**PO4**
CO3	Write the differential and integrated rate laws for zero, first, and second order reactions.	**PO1, PSO1**
CO4	Explain the kinetics of complex reactions, and work out the related rate laws.	**PO1**
CO5	Learn about different types of catalysis, along with their respective mechanisms.	**PO1, PSO2**
CO6	Understand the surface phenomenon, adsorption, along with its isotherms.	**PO4, PO5**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH202A	Physical Chemistry-III	3			3	2						2	2		

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**														
CO2				**3**											
CO3	**3**											**3**			
CO4	**3**														
CO5	**3**												3		
CO6				**3**	**3**										
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH252A	Physical Chemistry-III Practicals	L	T	P	C
Version 3.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of Chemistry				
Co-requisites	--				

Course Objectives

1. To be able to calibrate and take measurements on a conductometer and a potentiometer.
2. To learn to perform acid-base and redox titrations.
3. To find out dissociation constant of a weak acid.
4. To calculate the values of cell constant, equivalent conductance from the conductance measurements.

Course Outcomes

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

CO1. Understand the theory behind conductance of solutions.

CO2. Understand the theory behind potentiometric measurements.

CO3. Take readings on the instruments, conductometer and potentiometer.

CO4. Perform several acid-base titrations via conductometric titrations as well as potentiometric titrations.

CO5. Explain equations that relate, cell constant, equivalent conductance, and degree of dissociation to the conductance measurements.

CO6. Perform redox titrations between Mohr's salt and potassium dichromate potentiometrically.

Catalog Description

This course imparts the basic knowledge of conductometry and potentiometry, and how these measurements can be used to calculate various parameters. This course enables the students to perform several types of acid-base titrations, and redox titrations. It also discusses the calculations of cell constant, equivalent constant, and degree of dissociation for conductance measurements.

Course Content **30 lecture**

List of Experiments

Conductometry

1.Determination of cellconstant

2.Equivalent conductance, degree of dissociation and dissociation constant of a weak acid.

3.Conductometric titrations of: Strong acid Vs. strong base (ii) Weak acid vs. strong base, (iii) Mixture of strong acid and (iv)weak acid vs. strong base, Strong acid vs. weakbase.

Potentiometry

Potentiometric titrations of: (i) Strong acid vs. strong base (ii) Weak acid vs. strong base (iii) Dibasic acid vs. strong base (iv) Potassium dichromate vs. Mohr'ssalt.

Recommend books/References:

1.Khosla,B.D.;Garg,V.C.andGulati,A.*SeniorPracticalPhysicalChemistry*,R.Chand New Delhi,2011.

2.Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry* Eighth Edition*;* McGraw-Hill: New York,2003.

3.Halpern,A.M.andMcBane,G.C.*ExperimentalPhysicalChemistry3rdEd.;*W.H.Freeman& Co.: New York,2003.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped
CO1	Understand the theory behind conductance of solutions.	PO1
CO2	Understand the theory behind potentiometric measurements	PO4, PSO1
CO3	Take readings on the instruments, conductometer and	PO4
CO4	Perform several acid-base titrations via conductometric	PO1
CO5	Explain equations that relate, cell constant, equivalent	PO5, PSO2
CO6	Perform redox titrations between Mohr’s salt and	PO5

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH252A	Physical Chemistry-III Practicals	3			3	2						2	1		

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**														
CO2				**3**								**3**			
CO3				**3**											
CO4	**3**														
CO5					**3**								**3**		
CO6					**3**										
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH206A	Inorganic Chemistry-II	L	T	P	C
Version 3.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	General overview of s and p-block elements				
Co-requisites	--				

Course Objectives

1. To learn the students about oxidation- reduction and metallurgical processes
2. To learn the students structure, properties and uses of s and p-block elements
3. To study about the shapes and uses of noble gas compounds
4. To enable the students to gain detailed idea about B, Si , P based inorganic polymers

Course Outcomes

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

CO1. Acquaint with general concept of oxidation and reduction.

CO2. Provide information of purification of metals by different metallurgical processes.

CO3. Emphasize on chemical properties of s and p-block elements.

CO4. Understanding about the structure and uses of compounds from s and p-block elements

CO5. Learn the compounds of noble gases and structures on the basis of VSEPR and MO theory.

CO6. Learn about the preparation of inorganic compounds.

CO7. Learn about the structural aspects of inorganic polymers and their applications.

Catalog Description

In this course students learn about the oxidation-reduction reactions and the metallurgical process for the purification of metals. Students will learn some basic concepts of inorganic chemistry and the structure, properties, uses of compounds of s and p-block elements. The course will provide basics of noble gases, preparation and properties of some noble gases compounds. The students will also get an idea about structure and applications of various inorganic polymers based on silicon, boron and phosphorus.

Course Content

UNIT I: 15 Lectures

Oxidation-Reduction and general principle of metallurgy: Redox equations, Standard Electrode Potential and its application to inorganic reactions. Occurrenceofmetalsbasedonstandardelectrodepotentials.Ellinghamdiagramsforreductionof metal oxides using carbon or carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel- de Boer process and Mond's process, Zonerefining.

UNIT II: **15 Lectures**

Chemistry of *s* and *p* Block Elements

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behavior of first member of each group. Allotropy and catenation.Complex formation tendencyof*s*and*p*blockelements.Hydridesandtheirclassificationionic,covalentandinterstitial.Basic beryllium acetate andnitrate. Structure, bonding, preparation, properties and uses.Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine.Per-oxo acids of Sulphur inter-halogen compounds, poly- halide ions, pseudo-halogens, properties of halogens.

UNIT III: **15 Lectures**

Noble Gases Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, $XeF_4$and XeF_6; Bonding in noble gas compounds (Valence bond and MO treatment for XeF_2), Shapes of noble gas compounds (VSEPR theory).

UNIT IV: **15 Lectures**

InorganicPolymers

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphagens, and poly sulphates.

Textbooks

2. Lee, J. D. Concise Inorganic Chemistry, Wiley, 5th Edn.

Reference Books/Materials

1. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
2. Greenwood, N.N., Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
3. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
4. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.
5. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry Fourth Ed., Pearson, 2010
6. Atkins, P. W and Shriver D. N. Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Acquaint with general concept of oxidation and reduction.	**PO1**
CO2	Provide information of purification of metals by different metallurgical processes.	**PO1, PSO1**
CO3	Emphasize chemical properties of s and p-block elements.	**PO1**
CO4	Understanding about the structure and uses of compounds from s and p-block elements	**PO1**
CO5	Learn the compounds of noble gases and structures on the basis of VSEPR and MO theory.	**PO4**
CO6	Learn about the preparation of inorganic compounds.	**PO4, PO5**
CO7	Learn about the structural aspects of inorganic polymers and their applications.	**PO1, PSO1**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO 3	PSO4
BSCH206A	Inorganic Chemistry-II	3			2	2						2			

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**														
CO2	**3**											**3**			
CO3	**3**														
CO4	**3**														
CO5				**3**											
CO6				**3**	**3**										
CO7	**3**											**3**			
1=lightly mapped 2= moderately mapped 3=strongly mapped															

BSCH254A	Inorganic Chemistry-II Practicals	L	T	P	C
Version 3.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Inorganic preparation and iodometric analysis				
Co-requisites	--				

Course Objectives

1. To familiarize the students with quantitative analysis by iodometric and iodimetric titrations.
2. To expertise the students for inorganic salt preparation and use of analytical apparatus.

Course Outcomes

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

CO1. Learn the Quantitative analysis of unknown inorganic compounds.

CO2. Study iodometric and iodometric analysis.

CO3. Learn about inorganic salt preparation

CO4. Learn to perform inorganic experiments with various instruments

Catalog Description

This course helps to gain knowledge of quantitative analysis by iodometric and iodimetric titrations for the estimation. This course engages the students for simple inorganic salt preparation by using appropriate analytical method and handling of instruments. Students also get idea of using special apparatus and techniques for the synthesis.

Course Content **30 lecture**

(A) Iodo / IodimetricTitrations

(i) Estimation of Cu(II) and $K_2Cr_2O_7$using sodium thiosulphate solution(Iodimetrically).

(ii) Estimation of (i) arsenite and (ii) antimonyiodimetrically

(iii) Estimation of available chlorine in bleaching powderiodometrically.

(B) Inorganicpreparations

(i) Cuprous Chloride,Cu_2Cl_2

(ii) Preparation of Aluminium potassium sulphate (Potash alum) or Chromealum.

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

Textbooks

1. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis* Sixth Edition, Pearson,2009.

Reference Books/Materials

2. O. P. Pandey, D.N. Bajpai, S.Giri, Practical chemistry, S. Chand & Company Pvt. Ltd.

3. Svehala G. and Sivasankar I. B, Vogel's Qualitative Inorganic Analysis, Pearson, India, 2012.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	**Conduct of Experiment**	**Lab Record/Quizzes / Viva-Voce**	**Attendance**	**End Term PracticalExamination**
Weightage (%)	**20**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Learn the Quantitative analysis of unknown inorganic compounds.	**PO1, PSO2**
CO2	Study iodometric and iodimetric analysis.	**PO1, PO5**
CO3	Learn about inorganic salt preparation	**PO1**
CO4	Learn to perform inorganic experiments with various instruments	**PO4, PSO1**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 254A	Inorganic Chemistry-II Practicals	3			2	2						2	2		

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**												3		
CO2	**3**				3										
CO3	3														
CO4				3								3			
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH208A	Introduction to Quantum Chemistry	L	T	P	C
Version 2.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Chemistry and Calculus				
Co-requisites	--				

Course Objectives

1. To be able to appreciate the development of quantum mechanics.
2. To understand all the basic terms and postulates of quantum chemistry.
3. To write and solve Schrodinger wave equation for different systems.
4. To learn to carry out qualitative treatment of hydrogen and hydrogen like species.

Course Outcomes

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

CO1. Account for the basic principles and concepts of quantum chemistry.

CO2. Explain the experimental evidence for the shortcomings of classical mechanics that led to the development of quantum mechanics.

CO3. Understand and be able to explain the origin of quantized energy levels.

CO4. Write and solve Schrodinger wave equation for several different systems.

CO5. Understand valence bond and molecular approaches for hydrogen.

CO6. Perform treatment of hydrogen and hydrogen like molecules.

Catalog Description

This course imparts the basic concepts quantum mechanics. It enables them to understand the gaps in classical mechanics and how these knowledge gaps could be explained with the emergence of quantum mechanics. The course describes the fundamental terms and equations, the focus will be on Schrodinger wave equation. The course introduces the basic qualitative treatment for hydrogen and hydrogen like species.

Course Content

Unit I: 15 Lectures

Introduction to black-body radiation and distribution of energy, photo-electric effect, conceptofquantization,waveparticleduality(de-Broglie'shypothesis),Theuncertaintyprinciple,

The wave function: wave function and its interpretation, conditions of normalization and Orthogonality and its significance. Basic idea about operators, eigen function and values.

Unit II: **15 Lectures**

Schrodinger equation and application to free-particle and particle in a box, boundary conditions, wave functions and energies, degeneracy, hydrogen atom, Schrodinger equation in polar coordinates, radial and angular parts of the hydrogenic orbitals, degeneracies, spherical harmonics, representations of hydrogenic orbitals.

Unit III: **15 Lectures**

Quantitative treatment of simple harmonic osciallator model, setting up of Schodinger equation and discussion of solution of wave functions. Rigid rotator model and discussion of application of Schrodinger equation.idea about transformation to spherical polar coordinate, discussion on solution,

Unit IV: **15 Lectures**

Qualitativetreatmentofhydrogenatomandhydrogen-likeions:settingupofSchrödingerequation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Valence bond and molecular orbital approaches, LCAO-MO treatment of H_2, H^+; bonding and anti-bonding orbitals, Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and theirlimitations

Text Books

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.

Reference Books/Materials

1. Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
2. House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA(2004).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program**
CO1	Account for the basic principles and concepts of quantum chemistry.	**PO1**
CO2	Explain the experimental evidence for the shortcomings of classical mechanics that led to the development of quantum	**PO4**
CO3	Understand and be able to explain the origin of quantized energy levels.	**PO1, PSO1**
CO4	Write and solve Schrodinger wave equation for several different systems.	**PO5, PSO3**
CO5	Understand valence bond and molecular approaches for hydrogen.	**PO1, PSO3**
CO6	Perform treatment of hydrogen and hydrogen like molecules.	**PO1, PO5**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH208A	Introduction to Quantum Chemistry	3			2	3						2		2	

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**														
CO2				3											
CO3	3											**3**			
CO4					3									**3**	
CO5	**3**													3	
CO6	3				3										
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH256A	Introduction to Quantum Chemistry Practicals	L	T	P	C
Version 2.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of Chemistry				
Co-requisites	--				

Course Objectives

1. To be able to learn about basics of computational studies.
2. To build molecular models.
3. To learn to determine enthalpy of isomerization.
4. To take absorbance readings on a colorimeter and use it to verify Beer's law.

Course Outcomes

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

CO1. Perform basic computational experiments.

CO2. Carry out conformational analysis of butene.

CO3. Calibrate and use a colorimeter at different wavelength filters.

CO4. Explain the dissociation constant of a weak acid and how to calculate using colorimeter.

CO5. Understand Beer's law and its applications.

CO6. Find out the concentration of unknown solution by taking absorbance values.

Catalog Description

This course imparts the basic concepts of quantum chemistry practicals. It enables the students to build molecular models and carry energy calculations of various conformations. The course discusses the concept and usage of a colorimeter and how to find out dissociation constant with the help of absorbance values. The course introduces the Beer's law and protocol required for its verification.

Course Content **30 lecture**

List of Experiments

i) The students may be demonstrated hyperchem lab activities – building a molecular model (leveling of atoms, editing individual atoms, changing bond order, centrering, rotation of atoms), Selectionofcalculationmethod(*e.g.*forcefieldcalculation,ab-initiosetup),displayingcalculated properties, (instructor may demonstrate Computer programs that calculate the energy of various conformations of molecules and predict the lowest energy, to learn how to construct or draw representationsofmoleculesusingamolecularmodelingprogramcalledHyperChem(HyperCube, Inc.),to perform geometry optimizations (energy minimizations) to determine the lowest

energy conformations ofmolecules).
(Depending upon the availability of infrastructure facilities, instructor can demonstrate the students use of hyperchem software, Gaussian software – geometry optimization). They can be allowedforacademicvisittocomputationallabstogainknowledgeandareportmaybeconsidered forvivavoce/examination).Opensourcesoftwaresmaybeusedforlabdemonstrationandstudents may prepare a report along with viva-voce shall constitute practical examination. Instructor may encourage the students to gain hand-on experience in using open-source softwares (forperfoming various calculation as mentioned) in lab computers, periodic evaluation of which can also be accepted as conducting lab practical examination. Basic idea is to encourage the students to get knowledge without keeping any rigid practical syllabusframework).
(Examples of the computational work that can be done: Compare the optimized C-C bondlengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine πbonds.
ii) (a) Performaconformationalanalysisofbutane.(b)Determinetheenthalpyofisomerizationof *cis* and *trans* 2-butene.
iii) Visualize the electron density and electrostatic potential maps for LiH, HF, N_2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of thesemolecules. (Software: ChemSketch, Argus Lab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, or any similarsoftware.
iv) Determination of indicator constant -colorimetry.
v) Verification of Beer's Law - Determination of concentration of solution bycolorimetry.

Suggested books/reference books:
1.Essentials of computational chemistry – Theories and models, C. J. Crammer, Wiley, 2nd Edn.,
2.Principle and applications of quantum chemistry, V.K.Gupta, Elsevier, 2016.
3. Practicals in physical chemistry – a modern approach, P.S.Sindhu,Macmillan,
4. Experiments in Physical Chemistry, J.M.Wilson, R.J.Newcomb, A.R.Denaro, 2nd Edn., Elsevier.
5. A.R. Leach, *Molecular Modelling Principles and Application*, Longman,2001.
6. J.M. Haile, *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons,1997.
7. Gupta, S.P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers,2008.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes/ Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Perform basic computational experiments.	**PO1**
CO2	Carry out conformational analysis of butene.	**PO5**
CO3	Calibrate and use a colorimeter at different wavelength filters.	**PO4, PSO2**
CO4	Explain the dissociation constant of a weak acid and how to calculate using colorimeter.	**PO1**
CO5	Understand Beer's law and its applications.	**PO1, PSO1**
CO6	Find out the concentration of unknown solution by taking absorbance values.	**PO1**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 256A	Introduction to Quantum Chemistry Practicals	3			2	2						2	2		

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	3														
CO2					**3**										
CO3				3									**3**		
CO4	**3**														
CO5	3											**3**			
CO6	3														
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSMA274A	Introduction to LaTeX	L	T	P	C
Version 1.0		0	0	2	1
Total Contact Hours	15				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives:

The objective of the course is

1. To learn about a document preparation system for high-quality typesetting
2. To learn typesetting of complex mathematical formulas

Course Outcomes

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

CO1. Typesetting journal articles, technical reports, books, and slide presentations.

CO2. Control over large documents containing sectioning, cross-references

CO3. Automatic generation of bibliographies and indexes

Catalog Description

The course aims to introduce students to LaTeX - a high quality open-source typesetting software. LaTeX is most commonly used for medium to large technical or scientific documents, but can be used for almost any type of publication. The course will, therefore, enable students to type a report, article, or mathematical document.

Course Content **15 lecture**

ntroduction to LaTeX, Benefits and comparison with word processor, Installing LaTeX, Formatting lines and paragraph, Typesetting a simple document, Text alignment, installing packagesCreating Lists, Typing Math Formulas, Environments – equations, arrays, matrices, Footnotes, Fonts, Title and headers, Sectioning, Listing references, Math styles – cases, braces, math symbols. Graphics in LaTeX, Inserting Tables and Figures, Simple pictures using PSTricks, Sample article and report, Beamer presentation, Sample presentation, Using online resources

Textbooks

1. David F. Griffiths, Desmond J. Higham, Learning LaTeX, Society for Industrial and Applied Mathematics(SIAM), 2016.
2. Stefan Kottwitz , LaTeX Beginner’s Guide. Packt Publishing, Birmingham, UK, 2011.
3. Lamport, Leslie, LaTeX: A Document Preparation System, User’s Guide and Reference Manual (2nd ed.). Addison-Wesley, 1994.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Typesetting journal articles, technical reports, books, and slide presentations.	PO1
CO2	Control over large documents containing sectioning, cross-references	PO1,PSO1
CO3	Automatic generation of bibliographies and indexes	PO1, PO5

	Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
Introduction to LaTeX	3				2						2			

1=weakly mapped

2=moderately mapped

3=strongly mapped

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO3	PSO4
CO1	3														
CO2	**3**											3			
CO3	3				3										
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH210A	INTERNSHIP in Chemistry	L	T	P	C
Version 1.0		0	0	0	2
Total Contact Hours	30				
Pre-requisites/Exposure	Practical exposure				
Co-requisites	--				

Course Objectives

1. To learn how to carry out literature surveys on the assigned topic.
2. To be associated with an area of research/research project and contribute towards domain knowledge through hands on.
3. To learn the art of technical report writing.
4. To learn the art of verbal communication with the help of modern presentation techniques.

Course Outcomes

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

CO1. Carry out the extensive literature survey on the topic assigned by academicians and industry experts.

CO2. Learn to write and present technical reports/articles.

CO3. Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.

CO4. Learn to analyze/evaluate the result of the experiment carried out and present the results using data visualization methods.

Catalog Description

1. In the end of Semester IV, students will be asked to join research/academic organizations or industries to get hands on knowledge on the selected topics.
2. The student will work on the assigned topic for 3-4 weeks in regular consultation with his/her assigned expert/guide.
3. The student will write a report based on the work carried out during internship and prepare two copies to be submitted to the office of the Head of the Department duly signed by the student and the expert.
4. The student will make a power point presentation based on the work carried out and mentioned in the report to the board of examiners appointed by the University in the fifth semester. The student will be evaluated based on a report and presentation.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Internal (Interaction of Student with Supervisor)	External			Total
		Relevance of topic (20)	Presentation (20)	viva (10)	100
Weightage (%)	50	20	20	10	

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Carry out the extensive literature survey.	PO1, PO3
CO2	Learn to write and present technical reports/articles.	PO1, PO5, PO8, PO9
CO3	Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.	PO2,PO3,PO4, PSO1, PSO4
CO4	Learn to analyze/evaluate the result of the experiment carried out and present the results using data visualization methods.	PO5, PO6,PSO2 and PSO3

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH210A	Internship in Chemistry	3	3	3	3	3	3		3	3		3	2	3	3

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**		**3**												
CO2	**3**				**3**			**3**	**3**						
CO3		**3**	**3**	**3**								**3**			**3**
CO4					**3**	**3**							**2**	**3**	
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

SEMESTER V

BSCH301A	Inorganic Chemistry - III	L	T	P	C
Version 3.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of transition elements and inner transition elements				
Co-requisites	--				

Course Objectives

1. In order to study transition metals to understand the trends in properties and reactivity of the d-block elements
2. To explain the typical physical and chemical properties of the transition metals.
3. Describe the role of metal ions that are involved in electron-transfer reactions in biological systems.
4. To be able to name coordination compounds and to be able to draw the structure based on it's name.

Course Outcomes

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

CO1. Understand the coordination numbers and geometric shapes of the complexes.

CO2. To acquire knowledge of physical and chemical composition of the transition elements complexes.

CO3. Identify the main toxicological mechanisms of metals and the biological defenses against the toxic effects.

CO4. Apply the basic principles in inorganic and general chemistry to interdisciplinary topics in the field of bioinorganic chemistry.

CO5. The students will be able to explain the fundamental concepts in coordination chemistry of transition metals.

CO6. Know the chemistry of the Lanthanides and the Actinides.

Catalog Description

This course gives an introduction to coordination chemistry and an overview of important theories like crystal field theory, molecular orbital theory and their range of application within detection of structure of coordination compounds. Important magnetic and electrical properties of transition and inner transition elements are reviewed. The present course also includes main toxicological mechanisms of metals and the biological defenses against the toxic effects.

Course Content

UNIT I **15 Lecture**

Coordination Chemistry

Werner's theory, EAN rule, piano-stool compounds, valence bond theory (inner and outer orbital complexes), Crystal field theory, d-orbital splitting, , weak and strong fields, pairing energies, factors affecting the magnitude of (Δ). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar complexes, d orbital splitting in trigonal bipyramidal, square pyramidal and cubic ligand field environments, CFSE, Variation of lattice energies, enthalpies of hydration and crystal radii variations in halides of first andsecondrowtransitionmetalseries,QualitativeaspectofLigandfieldtheory,MOdiagramsof representative coronation complexes, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with the coordination number 4 and 6, Chelateeffect,

UNIT II **15 Lecture**

Transition Elements

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer &Bsworth diagrams). Difference between the first, second and third transition series. Chemistry of Ti,V, CrMn, Feand Coin various oxidation states(excluding their metallurgy)

UNIT III **15 Lecture**

Lanthanoids and Actinides

Electronic configuration, oxidation states, color, spectra and magnetic behavior, lanthanide contraction, separation of lanthanides (ion-exchange method only).

UNIT IV **15 Lecture**

Bioinorganic Chemistry

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on distribution of metals.Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), toxicity, chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

Recommended text books/References:

1. Purcell, K.F & Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977. Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
2. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company 1994.
3. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999
4. Basolo,F,andPearson,R.C.*MechanismsofInorganicChemistry*,JohnWiley&Sons,NY,1967. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann,1997.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the coordination numbers and geometric shapes of the complexes.	**PO1**
CO2	To acquire knowledge of physical and chemical composition of the transition elements complexes.	**PO1, PSO2**
CO3	Identify the main toxicological mechanisms of metals and the biological defenses against the toxic effects.	**PO3, PO4**
CO4	Apply the basic principles in inorganic and general chemistry to interdisciplinary topics in the field of bioinorganic chemistry.	**PO3, PSO1**
CO5	The students will be able to explain the fundamental concepts in coordination chemistry of transition metals.	**PO1**
CO6	Know the chemistry of the Lanthanides and the Actinides.	**PO1**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO 3	PSO4
BSCH 301A	Inorganic Chemistry -III	3		2	2							2	2		

1=weakly mapped2= moderately mapped3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	3														
CO2	**3**												3		
CO3			**3**	3											
CO4			**3**									3			
CO5	**3**														
CO6	**3**														
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH351A	Inorganic Chemistry-III Practicals	L	T	P	C
Version 3.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Gravimetric analysis and inorganic preparations				
Co-requisites	--				

Course Objectives

- To strenghten the students with gravimetric analysis of ions.
- To expertise the students for the preparation of coordination compounds in laboratory

Course Outcomes

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

CO1. To enable the students about general of Gravimetric Analysis and procedure

CO2. Students have knowledge about to estimate the amount of ions in solution

CO3. To enable the student about some experimental techniques of synthesis

CO4. To provide the student basic knowledge of laboratory equipments and chromatography

Catalog Description

This course imparts the understanding of quantitative analysis by gravimetric method and the whole procedure to find out the amount of ions present in solution. This course helps them to get experience of synthesizing coordination complexes with different structures. This course also introduces the chromatography for the separation of ions in solution.

Course Content **30 lecture**

(a)Quantitative Analysis: The following quantitative estimations are to be carried out.

(i) Estimation of nickel (II) using Dimethylglyoxime as the precipitant.

(ii) Estimation of copper as CuSCN

(iii) Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$ through (i) Heterogeneous and Homogeneous media.

(iv) Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminiumoxinate).

(b)Inorganic

Preparations:

(i) Tetraammine copper (II) sulphate, $[Cu(NH_3)_4]SO_4 H_2O$

(ii) Potassium trisoxalatochromate (III), $K_3[Cr(C_2O_4)_3]$

(iii) Cis and trans $K[Cr(C_2O_4)_2(H_2O_2]$ Potassium dioxalatodiaquachromate(III)

(iv) Pentaamminecarbonato Cobalt (III) ion

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

Textbooks

A I Vogel, A text book of Quantitative Inorganic Analysis (Prentice Hall)

Reference Books/Materials

3. G. Marr & B. W. Rockett, Practical Inorganic Chemistry, London; New York : Van Nostrand Reinhold, 1972.
4. O. P Pandey, D.N. Bajpai, S.Giri, Practical chemistry, S. Chand & Company Pvt. Ltd.
5. H.H Willard, L.L Meritt, I.A Dean, Instrumental Methods of Analysis, CBS Publishers, Delhi.
6. W. L. Jolly, The synthesis & characterization of Inorganic compounds, Prentice Hall.

R.A. Day and A.L. Underwood, Quantitative Analysis- 3 edition, Prentice Hall India, Pvt. Ltd.New Delhi, 1977.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	**Conduct of Experiment**	**Lab Record/Quizzes / Viva-Voce**	**Attendance**	**End Term PracticalExamination**
Weightage (%)	**20**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program**
CO1	To enable the students about general of Gravimetric Analysis and procedure	**PO1,PSO1**
CO2	Students have knowledge about to estimate the amount of ions in solution	**PO1**
CO3	To enable the student about some experimental techniques of synthesis	**PO1,PO5**
CO4	To provide the student basic knowledge of laboratory equipments and chromatography	**PO4, PSO2**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 351A	Inorganic Chemistry-III Practicals	3			2	2						2	2		2

1=weakly mapped2= moderately mapped3=strongly mapped

Programme and Course Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**											3			
CO2	**3**														
CO3	3				**3**										
CO4				**3**									3		
1=lightly mapped 2= moderately mapped 3=strongly mapped															

BSCH303A	Molecular Spectroscopy & Photochemistry	L	T	P	C
Version 1.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Physical Chemistry				
Co-requisites	--				

Course Objectives

1. To obtain theoretical and practical knowledge of modern molecular spectroscopic techniques.
2. To understand rotational, vibrational, Raman and electronic spectra, and use them to obtain information about the sample.
3. To study the concept of photochemistry and the Jablonski diagram.
4. To understand Beer-Lambert's law and its applications.

Course Outcomes

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

CO1. Understand the interactions of electromagnetic radiation and matter and their applications.

CO2. Analyse and interpret spectroscopic data to obtain information about the studied sample.

CO3. Explain rotational, vibrational, electronic and Raman spectra of molecules.

CO4. Understand theory and practice of common photochemical and photophysical methods.

CO5. Describe the various deactivation processes of molecular excited states.

CO6. Explain the mechanisms and kinetics of common photochemical transformations.

Catalog Description

The course explains the basic interactions between electromagnetic radiation with molecules and various types of spectra. It imparts in-depth knowledge about rotational, vibrational, and electronic spectroscopy which is useful in identifying the structure. The course explains the laws of photochemistry and Jablonski diagram. It also enables students to understand the kinetics of photochemical reactions in relation to electronic spectra and photochemistry.

Course Content

Unit I: 20 Lectures

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. 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 II: **20 Lectures**

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

Unit III: **20 Lectures**

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).

Text Books

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.

Reference Books/Materials

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

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the interactions of electromagnetic radiation and matter and their applications.	**PO1**
CO2	Analyse and interpret spectroscopic data to obtain information about the studied sample.	**PO2, PSO2**
CO3	Explain rotational, vibrational, electronic and Raman spectra of molecules.	**PO1**
CO4	Understand theory and practice of common photochemical and photophysical methods.	**PO1**
CO5	Describe the various deactivation processes of molecular excited states.	**PO4**
CO6	Explain the mechanisms and kinetics of common photochemical transformations.	**PO1,PO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH303A	Molecular Spectroscopy & Photochemistry	3	2		3								2		

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**														
CO2		**3**											2		
CO3	**3**														
CO4	**3**														
CO5				**3**											
CO6	2			**3**											
1=lightly mapped 2= moderately mapped 3=strongly mapped															

BSCH353A	Molecular Spectroscopy & Photochemistry Practicals	L	T	P	C
Version 1.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of Physical Chemistry				
Co-requisites	--				

Course Objectives

1. To be able to use colorimeter at different wavelength values.
2. To learn the numerical expression for Lambert-Beer's law.
3. To deduce concentration values using standard calibration curves.
4. To understand the ionisation of weak acids/ bases (indicators), and calculate their dissociation constant.

Course Outcomes

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

CO1. Use colorimeter to record absorbance values at different wavelengths.

CO2. Explain the theory and working principle of indicators.

CO3. Plot calibration curves for dyes and metal solutions.

CO4. Determine concentration of unknown solutions using absorbance values.

Catalog Description

This course imparts the basic concepts of colorimetry. data structures and algorithms. It enables students to understand the principle of indicators and to calculate their ionisation constant. The course introduces the stand calibration curve and how to use it to find out the concentration using absorbance values

Course Content **30 lecture**

List of Experiments

(i) Determination of indicator constant - colorimetry. (instructor may vary indicators available in the lab).

(ii). Verification of Beer's Law - Determination of concentration of solution by colorimetry. (Instructor may explain the principle of using colorimeter, its handling drawing standard calibration curve, and its application in finding unknown concentration of dyes, concentration of metal solutions (e.g.Ni, Cu using appropriate reagent) from standard calibration curve.

Text Books

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.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes/ Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Use colorimeter to record absorbance values at different wavelengths.	PO3
CO2	Explain the theory and working principle of indicators.	PO1, PSO1
CO3	Plot calibration curves for dyes and metal solutions.	PO1, PSO2
CO4	Determine concentration of unknown solutions using absorbance values.	PO5

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH353A	Molecular Spectroscopy & Photochemistry Praticals	3				2						2			

1=weakly mapped2= moderately mapped3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1			**3**												
CO2	**3**											2			
CO3	3												2		
CO4					**3**										
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

DISCIPLINE SPECIFIC ELECTIVE-I

BSCH305A	Medicinal Chemistry	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	12th level Chemistry				
Co-requisites	--				

Course Objectives

Study of the topics included in this course will enable the students to

- familiarize with the concept of Prodrug, drug and their classification.
- build a basic knowledge of the theory of drug activity, bio-physical and chemical properties and structure activity relationship.
- knowledge about some of the representative drugs and their mode of action.

Course Outcomes:

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

CO1: Understand the basics of medicinal chemistry, biophysicalproperties

CO2: Gain knowledge of various biological activityparameters

CO3: Compare the efficacy of the drug based on structure activity relationship and drugmetabolism

CO4: Discuss and learn biophysical and chemical properties of enzymes,hormones, vitamins

CO5: Apply the conceptsforrational drugdesign

Catalog Description

Medicinal chemistry is the discipline which involves intersection of synthetic organic chemistry, and pharmacology and various other biological specialties, where they are involved with design, chemical synthesis and development for market of pharmaceutical agents, or bio-active molecules (drugs).Medicines are required for treatment of different diseases and their action is dependent on their structure, stereochemistry, size and presence of different groups. This course provides an opportunity for understanding classification of drugs along with structure, mode of action and metabolism of some of the representative drugs. Biophysico-chemical properties of steroids, prostaglandins, enzyme, hormone and vitamins will also be discussed.

Course Content

UNIT I

Bio-physicochemical properties **15 lecture**

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

UNIT II

Structural properties **15 lecture**

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, Stereoselectivereceptorsorenzymessuchasmuscarinicreceptor,Stereochemicallypuredrugandre cemates, Examples such as catecholamines,etc.

UNIT III **15 lecture**

Drug target understanding.

Metabolism, Drug metabolism, Anti-metabolite, Enzyme inhibitor, Agonist, Antagonist, Examples.

Medicinal Chemistry of Therapeutic Agent

Structure, Chemistry, Mode of action and adverse effect of the representative therapeutic agents suchasAnti-infectiveagent,Antimalarials,Antibacterial,Antiviral,Anticancer,CNSactingdrugs, AdrenergicAgents,CholinergicDrugs,Diuretics,Cardivascular,localanestheticagent,Analgesic Agents, Histamine and Antihistamineagents

UNIT IV **15 lecture**

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.

Concept of rational drug design

Structureactivityrelationship, Drug-receptorunderstanding,Molecularmodeling,Structurebased drug design.QSAR.

Applications of Artificial Intelligence in drug delivery and development.

Recommended books/References:

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical ...by Charles Owens Wilson, John H. Block, Ole Gisvold, John MarloweBeale
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), MACKPublishing.
4. Burgers Medicinal Chemistry by Manfred E. Wolff, AlfredBurger
5. Burgers Medicinal Chemistry and Drug Discovery by Abraham D. J., Lewis F. L., Burger A., vol.5, 6thEdn., 2003, HobokenN.J.Wiley,
6. The Organic Chemistry of Drug Design and Drug Action by Silverman R. B., 2ndEdn., Academic Press.2012.
7. Exploring QSAR: Fundamental and applications in Chemistry and Biology by Hansch

C. and Leo, A American Chemical Society(1995)
8. Patrick, G. Medicinal Chemistry, Oxford.University Press(2000)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Learning Outcomes (PLOs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	The basics of medicinal chemistry, biophysicalproperties	**PO1**
CO2	Biological activityparameters	**PO1&PO3**
CO3	Drugmetabolism	**PO3**
CO4	Biophysical and chemical properties of enzymes,hormones, vitamins	**PO1**
CO5	Concept of rational drugdesign	**PO3, PSO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 305A	**Medicinal Chemistry**	3		3											2

1=weakly mapped2= moderately mapped3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**														
CO2	**3**		**3**												
CO3			**3**												
CO4	**3**														
CO5			**3**												2
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH 355A	Medicinal Chemistry Practicals	L	T	P	C
Version 1.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	12^{th} level Chemistry				
Co-requisites	--				

Course Objectives

In this course students will appreciate and comprehend the basic concepts regarding medicinal compounds, methods of synthesis of drugs, their importance for remediation and management of diseases.

Course Outcomes

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

CO1: understand the basics of medicinal chemistry

CO2: learn the synthesis of drugs

CO3: learn the purification and separation techniques

CO4: evaluate the biophysical and chemical properties of drugs

Catalog Description

Understanding of Medicinal Chemistry is very essential from the point of view of designing these molecules for various therapeutic applications. It is imperative that structure plays a very significant role in mitigating diseases. Through this course students will have experiential learning regarding purification and separation techniques, synthesis of various drug molecules, and understanding of biophysical properties of these compounds.

Course Content **30 lecture**

Practical wok suggested:

1. Purification Techniques of solvents by Fractional Distillation and Vacuum Distillation.
2. Thin Layer Chromatography Technique and Purification of commercially available drugs/Synthesized Compounds by ColumnChromatography.
3. Preparation of Acid/Basic Salts of Drugs and Evaluation of their Physicochemical Properties.(Benzilic Acid & Sodium Benzoate)
4. Synthesis & Purification of following Compoundsusing

i). precipitation or Recrystallization. ii) Synthesis of Benzimidazole.

(iii)Synthesis of Anthranilic Acid.(iv)Synthesis of Sulphanilamide.

(v)Synthesis of benzoic acid from benzyl alcohol.(vi)Synthesis of 1,4 – dihydropyridine.

5. Computational modeling of drug design/use of softwares may be demonstrated tostudents.

Suggested books/references:

1. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J. D.Barnes,
M. J. K Thomas, 6th Edition, Pearson's Education Ltd.
2. Advanced Practical Medicinal Chemistry, Ashutosh Kar, New Age International Ltd. (2004). 3.Vogel"s Textbook of Practical Organic Chemistry, B. S. Furniss, A. J. Hannaford ,P.W.G.
Smith, A. R Tatchell, 5th edition (2008), Pearson's Education Ltd

(The list of experiments and books are purly suggestive; University/institute may incorporate further changes in number of experiments and books/refererences (updated version from time to time) based on course design and available infrastructure facilities).

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Learning Outcomes (PLOs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program**
CO1	understand the basics of medicinal chemistry	**PO1, PSO4**
CO2	learn the synthesis of drugs	**PO5, PSO1**
CO3	learn the purification and separation techniques	**PO1, PO5, PSO2**
CO4	evaluate the biophysical and chemical properties of drugs	**PO1**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 355A	**Medicinal Chemistry Practicals**	3				2						2	2		2

1=weakly mapped2= moderately mapped3=strongly mapped

Programme and Course Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**														3
CO2					**3**							2			
CO3	**3**				3								2		
CO4	3														
1=lightly mapped 2= moderately mapped 3=strongly mapped															

BSCH307A	Heterocyclic Chemistry	L	T	P	C
Version 1.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of organic chemistry				
Co-requisites	--				

Course Objectives

1. To enable the students to understand Heterocyclic compounds and their reactions.
2. To enable the student to differentiate between two, three, four and five membered heterocyclic compounds with respect to the properties.

Course Outcomes

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

CO1. Understand the methods of preparation of variety of heterocyclic compounds and evaluate the ractivity of compounds based on their structure

CO2. Understand the chemistry of three membered heterocyclic compounds with one or two hetero atoms

CO3. Demonstrate the chemistry of four membered heterocyclic compounds

CO4. Gain knowledge and understanding about five membered condensed heterocyclic compounds

CO5. Predict the carbon skeleton of amines and heterocyclic compounds via use of Hoffmann's exhaustive methylation and Emde's modification methods

CO6. Evaluate the applications of heterocycles in medicines

Catalog Description

This course contains variety of two, three, four, five membered and condensed heterocyclic compounds. The syllabus also deals with important properties of such compounds.

Course Content

UNIT I

HeterocyclicChemistry **15 Lectures**

Three-membered rings with one heteroatom: Chemistry of oxiranes, aziridines and episulphides - synthetic approaches and reactivities.

UNIT II **15 Lectures**

Three-membered heterocycles with two heteroatoms: oxaziranes, diaziridines and diazirines- synthetic approaches and reactivities.

UNIT III **15 Lectures**

Four-membered heterocycles: oxitanes, azatidanes and thietanes - synthetic approaches and reactivities. natural products:synthesis of Peniciline andcephalosporine.

UNIT IV **15 Lectures**

Five-membered aromatic heterocycles:

1. With one heteroatom: furans, pyrroles and thiophenes - general synthetic approaches, properties andreactivities.
2. With two heteroatoms: oxazoles, isoxazoles, imidazoles, thiazoles, pyrazoles and isothiazoles - general synthetic approaches andreactivities.
3. With three and four heteroatoms: triazoles and tetrazoles - synthetic approaches, properties andreactivity.

Condensed five-memberedHeterocycles:

Benzofuran, indoles and benzothiazoles - general synthetic approaches, with greater emphasis on the chemistry ofIndoles

Recommended Books/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.
4. Heterocyclic Chemistry, J.A. Joule and G. F. Smith, van Nostrand, London,1978.
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.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Enhance the skill of learning about Preparation and variety of heterocyclic compounds reactions	**PO1, PO7**
CO2	Understand two membered heterocyclic compounds.	**PO1**
CO3	Understand three and four membered heterocyclic compounds.	**PO1**
CO4	Understand five membered condensed heterocyclic compounds.	**PO1**
CO5	Predict the carbon skeleton of amines and heterocyclic compounds via use of Hoffmann's exhaustive methylation and Emde's modification methods.	**PO1**
CO6	Understand the applications of these compounds including their medicinal applications through their reaction chemistry.	**PO3, PSO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 307A	Heterocyclic Chemistry	3		1				1							1

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**						2								
CO2	**3**														
CO3	3														
CO4	3														
CO5	3														
CO6			**3**												2
1=lightly mapped 2= moderately mapped 3=strongly mapped															

BSCH357A	Heterocyclic Chemistry Practicals	L	T	P	C
Version 1.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of organic compounds				
Co-requisites	--				

Course Objectives

1. To enable the student for hands on learning by experiments.
2. To generate confidence among students to perform reactions or analysis.

Course Outcomes

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

CO1. Learn Qualitative analysis of elements of unknown organic compounds.

CO2. Learn Qualitative analysis of simple organic compounds by using column chromatography/TLC.

CO3. Application of Spectroscopy for identification of simple organic compounds.

CO4. Understand the preparation of Dyes.

CO5. Learn about the environment safety at the time of performing experiment.

Catalog Description

In this course Identification of hetero atoms, Identification/separation of simple organic compounds containing hetero atoms using column chromatorgapy/TLC, Spectroscopic identification of simple organic compounds and preparation of Indigo dye, are available.

Course Content **30 lecture**

List of suggested laboratory experiments

1. Identification of hetero atoms (S, N, X) in given organic compounds inlab.
2. Identification/separation of simple organic compounds containing hetero atoms using column chromatorgapy/TLC) inlab.
3. Spectroscopic identification of simple organic compounds (spectra may be provided to the students and teachers may help the students to identify the compounds using spectra). Melting point/boiling point of the compounds may be checked for itspurity.
4. Teacher may guide the students for preparation of : Indigo (using aldol condensation reaction of 2-nitrobenzaldehyde with acetone in basiccondition);

(Depending upon laboratory facilities, more preparation of heterocyclic group of compoundsmay be incorporated byteacher).

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Learn Qualitative analysis of elements of unknown organic compounds.	**PO1, PSO2**
CO2	Learn Qualitative analysis of simple organic compounds by using column chromatorgapy/TLC.	**PO4, PSO2**
CO3	Application of Spectroscopy for identification of simple organic compounds.	**PO4, PO5**
CO4	Understand the preparation of Dyes.	**PO1**
CO5	Learn about the environment safety at the time of performing experiment.	**PO7**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 357A	Heterocyclic Chemistry Practicals	3			3	2		2					3		

1=weakly mapped2= moderately mapped3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**												3		
CO2				**3**									3		
CO3				**3**	3										
CO4	**3**														
CO5							3								
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

DISCIPLINE SPECIFIC ELECTIVE-II

BSCH309A	**Advanced Material Chemistry**	L	T	P	C
Version 1.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Physical chemistry or an equivalent course is recommended				
Co-requisites	--				

Course Objectives

1. To understand the crystal structure of solids, fundamental of lattices, unit cell, atomic coordinates, Bravais lattices, crystal direction and planes, types of close packing, packing efficiency, radius ratios; few important crystal structures.
2. To acquire the knowledge of synthesis of Inorganic solids in solid state, solution phase and vapor phase by the processes as precipitation, hydrothermal, sol-gel, surfactant based synthesis.
3. Able to synthesize nanowires and nanotubes by CVD and MOCVD method along with understanding of Magnetic properties of nanoparticles.
4. To develop biodegradable polymers, conducting polymers, fibers and rubber.

Course Outcomes

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

CO1. Able to interpret the basic materials chemistry that underpins current and emerging technologies as well as some of the novel classes of materials being developed for future applications.

CO2. To acquire knowledge of instrumental characterization methods and their interpretation.

CO3. Gain knowledge on wide variety of advanced materials like nano and smart materials which have excellent physical and chemical properties.

CO4. Identify different types of polymers, composites and their applications in various fields.

CO5. Get trained in conducting scientific experiments, recording and analyzing experimental data.

CO6. Solve problems and carry out scientific investigations.

Catalog Description

Materials chemistry is the study of the synthesis, structure, properties, and application of solid materials.Our technology-driven world is fueled by advances in materials chemistry with examples of applicationin areas such as microelectronics, polymers, and energy technology. This course will explain theapplication of materials chemistry through the materials properties and characterization, detailing howthe crystalline and molecular structure of materials can be related to electronic, optical, thermal, andmechanical properties.

Course Content

UNIT I **15 Lecture**

Crystal structure of solids

Fundamentaloflattices,unitcell,atomiccoordinates,Bravaislattices,crystaldirectionandplanes, types of close packing, packing efficiency, radius ratios; few important crystalstructures.

Synthesis of Inorganic solids; solid state, solution phase and vapor phase synthesis; precipitation, hydrothermal, sol-gel, surfactant based synthesis. Growth of single crystals.

Crystal structure determination by X-ray diffraction, d-spacing formula, symmetrically absent reflections,Multiplicities,ScatteringofX-raysbyanatomandacrystal.Singlecrystalandpowder diffraction. Electron and neutron diffraction.Concept of reciprocal lattice.Electron microscopy techniques.

UNIT II

Nanomaterial fundamentals **15 Lecture**

Synthesis: Bottom-up vs. Top-down Methods. Solution phase synthetic methods. Role of surfactant in shape and size control of nanomaterials.Synthesis of nanowires and nanotubes by CVD and MOCVD method.

UNIT III **15 Lecture**

Nanomaterials Characterization: XRD of nanomaterials, Electron microscopy (SEM, TEM, HRTEM and EDX) of nanomaterials, Scanning probe microscopy.

Nanomaterial properties and applications: Magnetic properties of nanoparticles; superparamagnetism, ferromagnetism in antiferromagnetic nanoparticles and single domain to multidomain transition. magnetic nanoparticles as MRI contrast agents.

UNIT IV **15 Lecture**

Frontier areas of polymer science and technology

Conducting polymers: basic principles of conducting polymers, delocalized electronic states of conjugated polymers, polyanilines, polyacetylenes, polythiophene, applications of conducting polymers.

Biodegradable polymers: Definition classification of natural biodegradable polymers, cellulose, cellulose acetate, cellophane, soy protein, corn, zein protein, wheat gluten protein, synthetic biodegradable polymers, polyhydroxy alkanoates, polycarpolactone, poly(vinyl alcohol), polyacetic acid, application of biodegradable and biomedical polymers, contact lens, dental polymers, artificial heart, kidney, skin, and blood cells.

Fibers: natural fibers, cotton, wool, silk, rayon, artificial fibers, polyamides, acrylic acid, PVC, PVA.

Rubber: Compounding and elastomeric properties, vulcanization, reinforcement.

Recommended books/References:

1. ZhenGuoandLiTan,*FundamentalsandApplicationsofNanomaterials*.2009,ArtechHouse, LondonPublication.
2. Physical methods for chemistry: R. S. Drago, 1992, Saunders collegepublication.
3. Polymerscience,V.R.Gowariker,N.V.Viswanathan,J.Sreedhar,NewAgeInternational(P) Ltd.,2015.
4. P. J. Flory, Principle of polymer chemistry, Cornell UniversityPress.
5. Polymer Science and technology, Plastics, Rubber and composites, P. Ghosh, Tata McGraw Hill.
6. V. Gowriker, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age Int.Publication, 2019.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped
CO1	Able to interpret the basic materials chemistry that underpins current and emerging technologies as well as some of the novel classes of materials being developed for future applications.	PO1
CO2	To acquire knowledge of instrumental characterization methods and their interpretation.	PO4, PSO2
CO3	Gain knowledge on wide variety of advanced materials like nano and smart materials which have excellent physical and chemical properties.	PO1
CO4	Identify different types of polymers, composites, and their applications in various fields.	PO1
CO5	Get trained in conducting scientific experiments, recording, and analyzing experimental data.	PO4, PSO2
CO6	Solve problems and carry out scientific investigations.	PO1, PO2

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 309A	Advanced Material Chemistry	3	1		3								1		

1=weakly mapped2= moderately mapped3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**														
CO2				**3**									3		
CO3	**3**														
CO4	**3**														
CO5				**3**											
CO6	3	3													
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

SEMESTER V					
BSCH359A	**Advanced Material Chemistry Practicals**	L	T	P	C
Version 1.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of analytical chemistry				
Co-requisites	-				

Course Objectives

1. To develop an understanding of the range and uses of analytical methods in chemistry.
2. To establish an appreciation of the role of chemistry in quantitative and qualitative analysis
3. To develop an understanding of the broad role of the chemist in measurement and problem solving for analytical tasks.
4. To provide experience in some scientific methods employed in analytical chemistry.

Course Outcomes

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

CO1. Experience of research design and management.

CO2. Handle advanced instrumentation or techniques.

CO3. Able to produce of scientific reports.

CO 4. Assess the appropriate methods of data collection/analysis to address the research question.

CO5. Understand the basic principles associated with spectrophotometry and discuss how these are applied to the various specific applications.

CO6. Discuss the practical considerations appropriate for the application of these methods to typical chemical analyses (e.g. sensitivity, detection limits, linear response ranges, interferences, etc.)

Catalog Description

This course first offers an introduction to nanomaterials and their preparation method by bottom-up and top-down method. Sampling, Specific analytical techniques or concepts covered are: complexometric titration, spectrophotometric analysis and morphology analysis of particles. These topics will be covered from the point of view of theory, the associated analytical instrumentation and relevant computational methods.

Course Content **30 lecture**

List of suggested Laboratory Experiment

(The lists of experiments are suggestive. However, faculties/academic bodies may add more experiments/references or incorporate suitable revisions based on infrastructure facilities available).

1. Preparation of gold and silvernano-particles.
2. Interfacial polymerization, preparation of polyester from isophthaloylchloride(IPC) andphenolphthalein

3. Determination of composition of dolomite (by complexometrictitration).
4. Analysis of XRD pattern of few selected crystals like $NaNO_3$, $CaCl_2$, etc.; Indexing of a given powder diffraction pattern of a cubic crystallinesystem.
5. Interpretation of FTIR, NMR and UV-Vis data of givenmaterial.
6. Estimation of particle size from the BET, SEMtechniques.

Recommended books/Reference Book:

1.Fahlman, B.D. *Materials Chemistry,* Springer, 2004.

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Experience of research design and management.	PO5
CO2	Handle advanced instrumentation or techniques.	PO4, PSO1
CO3	Able to produce of scientific reports.	PO1, PO2
CO4	Assess the appropriate methods of data collection/analysis to address the research question.	PO2
CO5	Get trained in conducting scientific experiments, recording, and analyzing experimental data.	PO1, PO5, PSO1
CO6	Solve problems and carry out scientific investigations.	PO2, PSO2

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 359A	Advanced Material Chemistry Practical	2	3		1	2						1	1		

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

Programme and Course Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1					**3**										
CO2				**3**								3			
CO3	3	**3**													
CO4		**3**													
CO5	3				**3**										
CO6		3											3		
1=lightly mapped 2= moderately mapped 3=strongly mapped															

BSCH321A	Organometallic and Bioinorganic Chemistry	L	T	P	C
Version 2.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of transition elements and metal ions present biological system				
Co-requisites	--				

Course Objectives

1. To understand variable oxidation state of some transition elements.
2. To learn about the basics of organometallic compounds.
3. To describe the role of metal ions in biological system
4. To learn synthesis of organometallic compounds like ferrocene.

Course Outcomes

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

CO1. Learn about variable oxidation state of transition elements like Cr, Fe, Co and Ni.

CO2. Learn to develop the ability to understand basics of organometallic compounds, concepts of hepaticity, EAN rule and back pi bonding.

CO3. Get information about various common compounds of transitions elements which are used in laboratory on daily basis.

CO4. To predict and understand the function of Mg2+ and Ca2+ ions in daily basis life.

CO5. Familiar with synergic effects that have wide application in chemistry especially metathesis, catalysis and infra-red analysis.

CO6. Able to describe the role and chemistry of metal ions in human life.

Catalog Description

This course imparts basic knowledge of organometallic compounds including their structure, preparation and properties. This course introduces different types of mononuclear and polynuclear carbonyl of 3d metals. The course will provide a basic understanding of the metal ions in biological system like role of Ca^{2+} in blood clotting, Mg^{2+} in energy production.

Course Content

UNIT I **15 Lectures**

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 ofCr, K_2Cr_2O7, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$,$Na_3[Co(NO_2)_6]$.

UNIT II **15 Lectures**

Organometallic Compounds: Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. 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 bondingZeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

UNIT III **15 Lectures**

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.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 IV

Bioinorganic chemistry: **15 Lectures**

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).

Recommended books/reference books

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

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Learn about variable oxidation state of transition elements like Cr, Fe, Co and Ni.	**PO1**
CO2	Learn develop the ability to understand basics of organometallic compounds, concepts of hepaticity, EAN rule and back pi bonding.	**PO1**
CO3	Get information about various common compounds of transitions elements which are used in laboratory on daily basis.	**PO1**
CO4	To predict and understand the function of Mg^{2+} and Ca^{2+} ions in daily basis life.	**PO3**
CO5	Familiar with synergic effect that have wide application in chemistry especially metathesis, catalysis and infra-red analysis.	**PO1, PSO2**
CO6	Able to describe role and chemistry of metal ions in human life.	**PO3**

		Enhancement in Advanced Scientific	Development of critical, logical and	Demonstrate interdisciplinary approach	Learning of fundamental concepts and	Orientation towards research and	Acquiring capability to work	Understanding of impact of chemicals on	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional	Systematic and coherent understanding	Appreciate the techniques for the	Learn problem solving approach	Apply principles of chemistry to address
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 321A	Organo metallic and	3		2									1		

	Bioinorganic Chemistry														

1=weakly mapped
2= moderately mapped
3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**														
CO2	3														
CO3	**3**														
CO4			3												
CO5	**3**												3		
CO6			3												
	1=lightly mapped				2= moderately mapped							3=strongly mapped			

BSCH371A	**Organometallic and Bioinorganic Chemistry Practicals**	L	T	P	C
Version 2.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of water quality parameters				
Co-requisites	--				

Course Objectives

1. To learn about synthesis of coordination complexes.
2. To learn about preparation of Grignard reagent and dye using Grignard reagent.
3. To determine conductivity of metal complexes.
4. Performing risk assessment of chemical experiments and chemical analytical activity

Course Outcomes

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

CO1. Understand simple methods used for synthesis of metal complexes.

CO2. Describe the applications of Grignard reagent used for preparation of dye and other compounds.

CO3. Enable to prepare Schiff base-metal complexes and their application for water purification.

CO4. Students will learn the application of spectroscopy and conductometry in such ways to make informed conclusions and decisions about controversial environmental issues.

CO5. Learn to work with others as part of a team to solve scientific problems.

CO6. Trained in analytical and instrumental skills required for their development.

Catalog Description

This course covers some simple methods for preparation of metal complexes in the laboratory and their identification using different analytic techniques like spectroscopy and conductometry. The course also gives hand on experience to use analytical instruments which will help them to think about the research work.

Course Content **30 lecture**

List of Laboratory experiments

(necessary infrastructure may be developed and adequate precaution should be maintained to conduct such experiments; instructor may demonstate the experiment to students)

1. Rection of metal with halide – preparation of Grignard reagent. (only demonstrationpurpose)
2. Grignard preparation of dye (malachite green (using methylbenoate)/crystal violet (using diethylcarbonate) (starting material as p-bromo N, N-dimethyl aniline) (only demonstration purpose)
3. PreparationofvariousSchiffbase-metalcomplexesandtheiridentificationusingspectroscopy.
4. Preparation of any two of the following complexes and measurement of their conductivity measurement:

a. tetraamminecarbonatocobalt (III) nitrate
b. tetraamminecopper (II)sulphate
c. potassium trioxalatoferrate (III) trihydrate

Recommended books/reference books

1. Synthesis of organometallic compounds: A practical guide, S. Komiya,Wiley.
2. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7thEdn.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*,Prentice-Hall,

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos

	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Understand simple methods used for synthesis of metal complexes.	**PO1, PSO1**
CO2	Describe the applications of Grignard reagent used for preparation of dye and other compounds.	**PO5**
CO3	Enable to prepare Schiff base-metal complexes and their application for water purification.	**PO1, PO6, PSO1**
CO4	Students will learn the application of spectroscopy and conductometry in such ways to make informed conclusions and decisions about controversial environmental issues.	**PO6, PSO2**
CO5	Learn to work with others as part of a team to solve scientific problems.	**PO8**
CO6	Trained in analytical and instrumental skills required for their development.	**PO4, PSO2**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH371A	Organometallic and Bioinorganic Chemistry Practicals	2			1	1	3		1			3	2		

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**											3			
CO2					**3**										
CO3	3					**3**						3			
CO4						**3**							3		
CO5								**3**							
CO6				3									3		
1=lightly mapped 2= moderately mapped 3=strongly mapped															

BSCH304A	Environmental Chemistry	L	T	P	C
Version 1.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Environment				
Co-requisites	--				

Course Objectives

1. To aware the students about four spheres of environment.
2. To learn the students about different types of pollution and their impact on environment.
3. To demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
4. To communicate environmental concerns and awareness to audiences in relevant formats in a straightforward and professional manner.

Course Outcomes

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

CO1. Recognize different types of toxic substances & responses and analyze toxicological information.

CO2. Apply basic chemical concepts to analyze chemical processes involved in different environmental problems (air, water & soil).

CO3. Describe water purification and waste treatment processes and the practical chemistry involved.

CO4. Describe causes and effects of environmental pollution by energy industry and discuss some mitigation strategies.

CO5. Explain energy crisis and different aspects of sustainability.

CO6. Discuss local and global environmental issues based on the knowledge gained throughout the course.

Catalog Description

This course imparts the knowledge of composition of atmosphere and biogeochemical cycle of major nutrients like C, N, P, S and O system. The course introduces analytical methods for determination of heavy metals present in water. This course helps them to get an idea of adverseeffect of industrialization, population and degradation of natural resources on the environment due to which concentration of greenhouse gases, air pollutant is increasing.

Course Content

UNIT I **15 Lecture**

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 **15 Lectures**

Hydrosphere:

Hydrological cycle, aquatic pollution and water quality parameters – Dissolve oxygen, biochemical oxygen demand, chemical oxygen demand, Analytical methods for the determinationfluoride,chromiumandarsenic,residualchlorineandchlorinedemand,purification and treatment of municipal water and waste water.

UNIT III **15 Lectures**

Atmosphere:

Chemicalcompositionofatmosphere–particle,ions,andradicalsintheirformation,chemicaland photochemicalreactionsinatmosphere,smogformation,oxidesofN,C,S,andOandtheireffect, pollution by chemicals, CFC, Green House effect, acid rain, air pollution andcontrol.

UNIT IV **15 Lectures**

Aquatic chemistry:

Water and its necessities, various water quality parameters (DO, BOD, COD, conductivity, pH, alkalinity,hardness)anditsdetermination,Industrial,municipalwatertreatmentprocesses,Waste watertreatmentprocedure(primary,secondaryandtertiary),Solidwastetreatment.Soilpollution and Noisepollution.

Recommended Books/References:

1. De.A.K.Environmental Chemistry, Wiley Eastern Ltd,1990.
2. Miller T.G.Jr., EnvironmentalScience, 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, Krishnapublishers
6. Environmental Pollution, Monitoring and control, S.M. Khopker, 2007, New Age International.
7. Environmental chemistry, C. Baird, M. Cann, 5thEdn, 2012, W.H.Freemanpublication.

9G. S. Sodhi Fundamental Concepts of Environmental Chemistry (Third Edition) Narosa(2009).

10. Principles of instrumental analysis: D. A. Skoog, Fifth Edition, Sauns College Publishing (London)

11 Basic concepts of analytical chemistry: S. M. Khopkar, Wiley Eastern(1995)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Recognize different types of toxic substances & responses and analyze toxicological information.	**PO1, PO3,**
CO2	Apply basic chemical concepts to analyze chemical processes involved in different environmental problems (air, water & soil).	**PO2, PSO2**
CO3	Describe water purification and waste treatment processes and the practical chemistry involved.	**PO5, PO7**
CO4	Describe causes and effects of environmental pollution by energy industry and discuss some mitigation strategies	**PO7**
CO5	Explain energy crisis and different aspects of sustainability.	**PO7, PO10**
CO6	Discuss local and global environmental issues based on the knowledge gained throughout the course.	**PO7, PSO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 304A	Environmental Chemistry	1	1	1		1		3			1		2		2

1=weakly mapped 2= moderately mapped 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	3		3												
CO2		**3**											2		
CO3					**3**		3								
CO4							**3**								
CO5							3			**3**					
CO6							3								2
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH354A	Enviromental Chemistry Practicals	L	T	P	C
Version 1.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of water quality parameters				
Co-requisites	--				

Course Objectives

1. To introduce water quality parameters like COD, BOD, DO.
2. To learn about determination of water quality parameters.
3. To determine the %age of chlorine in bleaching powder.
4. To determine alkalinity of water sample.
5. Performing risk assessment of chemical experiments and chemical analytical activity

Course Outcomes

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

CO1. Understand the basic principles involved in analytical techniques.

CO2. Describe water purification and waste treatment processes and the practical chemistry involved.

CO3. Enable how to communicate scientific information clearly and accurately, both in oral and in written forms.

CO4. Students will learn to think analytically and assess information in such ways to make informed conclusions and decisions about controversial environmental issues.

CO5. Learn to work with others as part of a team to solve scientific problems.

CO6. Trained in analytical and instrumental skills required for environmental monitoring of pollutants.

Catalog Description

This course covers some simple methods for determination water quality parameter like COD, BOD, and DO. The course also gives hand on experience for determination of some major anions present in water sample.

Course Content **30 lecture**

List of suggested laboratory practical

Determination of water quality parameters in following aspect:

1. Determination of dissolved oxygen in given water (chemical method/instrumentation method).

2.Determination of Biological Oxygen Demand (BOD_5).

3. Determination of Chemical Oxygen Demand(COD).
4. Finding out percentage of available chlorine in bleachingpowder.
5. Measurement of chloride, sulphate and salinity of water samples by titration method ($AgNO_3$ and potassiumchromate).
6. Estimation of total alkalinity of water samples (carbonate, bicarbonate) by titrationmethod.
7. Estimation of SPM in airsamples.

List of Recommended books/Reference Books:

1. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, John Wiley & Sons, Inc. Publishers, New Delhi.(2005 edition).
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, NewDelhi.
4. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. NewDelhi.
5. A. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, NewDelhi.
6. S. M. Khopkar, *Environmental Pollution Analysis*: New Age Int. Publisher, NewDelhi.

(The list of experiments and books are purly suggestive; University/institute may incorporate further changes in number of experiments and books/refererences (updated version from time to time) based on course design and available infrastructure facilities).
(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Conduct of Experiment**	**Lab Record/Quizzes / Viva-Voce**	**Attendance**	**End Term PracticalExamination**
Weightage (%)	**20**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the basic principles involved in analytical techniques.	**PO1**
CO2	Describe water purification and waste treatment processes and the practical chemistry involved.	**PO5, PO7, PSO4**
CO3	Enable how to communicate scientific information clearly and accurately, both in oral and in written forms.	**PO6**
CO4	Students will learn to think analytically and assess information in such ways to make informed conclusions and decisions about controversial environmental issues.	**PO6, PO7**
CO5	Learn to work with others as part of a team to solve scientific problems.	**PO8, PSO3**
CO6	Trained in analytical and instrumental skills required for environmental monitoring of pollutants.	**PO2, PO7, PSO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 354A	Environmental Chemistry Practical	2	1			2	3	3	1					2	2

1=weakly mapped 2= moderately mapped 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**														
CO2					**3**		3								3
CO3						**3**									
CO4						**3**	3								
CO5								**3**							
CO6		**3**					3							3	3
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH306A	Organic Spectroscopy	L	T	P	C
Version 3.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	12th level Chemistry				
Co-requisites	--				

Course Objectives

In this course students will learn and understand the basic concepts of spectroscopy, difference between emission and absorption spectroscopy, laws of photochemistry, basic principles and working of UV-Visible, IR, NMR, Mass Spectroscope and how structure of organic molecules can be predicted based on UV-Visible, IR, NMR and mass spectrum.

Course Outcomes

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

CO1: Gain knowledge about the basic concept of absorption and emission spectroscopy,fundamentals of UV-Visible spectroscopy.

CO2: Learn the principle of instrumentation and applications of IR, ^{1}H NMR and^{13}C spectroscopy.

CO3: Understand the mass fragmentation pattern of organic compounds.

CO4: Analyze IR, UV, NMR, Mass spectrometry data and elucidate the structure of simple organic molecules based upon that data.

Catalog Description

Number of organic compounds is synthesized in the laboratories as they are used for several applications such as pesticides, food, cosmetics, essential oils, fats and oils, medicines, paints and varnishes, polymers etc. It is important to understand and establish their structure based on spectroscopic tools such as UV-Visible, IR, NMR and Mass spectroscopy. While on one hand, UV-Visible confirms saturation and unsaturation in the molecule on the other hand IR helps to find out the type of functional group present in the organic molecule. NMR determines the number and type of protons or ^{13}C in the molecule and mass spectroscopy determines the molecular ion peak. In short, all this helps in characterization or structural elucidation of the organic moiety. In this course, the focus will be on thorough understanding of concepts of spectroscopy through class room teaching, video lectures, expert talks and analysis of data available for known compounds. Large number of practice problems will be discussed so that students acquire the technique and knowledge to handle the subject in appropriate manner.

Course Content

UNIT I **15 lecture**

Basic Principles of UV Spectroscopy:

Application of Woodward-Fieser rule in interpretation of Organic compounds: Application of visible, ultraviolet and infrared spectroscopy in organic molecules. Electromagnetic radiation, electronictransitions,λmax&εmax,chromophore,auxochrome,bathochromicandhypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λmax of conjugated dienes and α,β – unsaturatedcompounds.

UNIT II **15 lecture**

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 III **15 lecture**

NMR (^{1}H and ^{13}C NMR):

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

UNIT IV **15 lecture**

Basic principles Mass Spectrometry:

Applicationoffragmentationruleincharacterizationoforganiccompounds.Problemsonstructure elucidation of organic compounds based on spectraldata.

Recommended Books/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).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Learning Outcomes (PLOs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the basic concept of absorption and emission spectroscopy, fundamentals of UV-Visible spectroscopy.	**PO1, PO4**
CO2	Learn the principle of instrumentation and applications of IR, ^{1}H NMR and ^{13}C spectroscopy.	**PO1, PO4**
CO3	To understand the mass fragmentation pattern of organic compounds	**PO1, PO2**
CO4	To analyze IR, UV, NMR, Mass spectrometry data and elucidate the structure of simple organic molecules based upon that data.	**PO2, PO4, PSO2, PSO3**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 306A	**Organic Spectroscopy**	3	2		3								2	2	

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**			3											
CO2	**3**			3											
CO3	**3**	3													
CO4		3		**3**									3	3	
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH356A	Organic Spectroscopy Practicals	L	T	P	C
Version 3.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	12^{th} level Chemistry				
Co-requisites	--				

Course Objectives

In this course students will learn and understand the basic concepts of spectroscopy, understanding of basic principles and working of UV-Visible, IR, NMR, Mass Spectroscope and how structure of organic molecules can be predicted based on UV-Visible, IR, NMR and mass spectrum.

Course Outcomes

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

CO1: understand the working of UV-Visible spectroscope.

CO2: learn the principal and applications of IR.

CO3: understand ^{1}H NMR and ^{13}C spectroscopy

CO4: analyze IR, UV, NMR, Mass spectrometry data and elucidate the structure of simple organic molecules based upon that data.

Catalog Description

In this course, the focus will be on thorough understanding of concepts of spectroscopy through hand on synthesis of organic compounds such as dyes and other organic compounds and take their IR NMR etc. Assign and establish their peaks. Based on data compounds needs to be identified.

Course Content **30 lecture**

Suggested laboratory experiments

1. Purification method for liquid, solid organic substance (distillation, recrystallization, chromatography)
2. Analysis of spectra of UV-VIS, FTIR, NMR and Mass of simple organic compounds. (students may encourage to prepare simple organic compounds following given protocol (azodyes, acetanilides, benzoic acid, etc.) (or may use commercially available organic compounds) and can be trained to identify/analyze important peaks/functionality, determine mass of the molecules (mass-spectra). They can submit a report regarding their analysis to courseteacher.

(Note: A candidate must perform at least eight experiments in the lab. Any suitable experiment may be added.)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Learning Outcomes (PLOs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the synthesis of simple organic compounds and their characterization	**PO1, PSO1**
CO2	Learn the principle of instrumentation and applications of IR, ^{1}H NMR and^{13} C spectroscopy.	**PO1, PO4, PSO1**
CO3	To understand the mass fragmentation pattern of organic compounds	**PO1, PO2, PSO1**
CO4	To analyze IR, UV, NMR, Mass spectrometry data and elucidate the structure of simple organic molecules based upon that data.	**PO2, PO4, PSO1, PSO2, PSO3**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 356A	**Organic Spectroscopy Practicals**	3	2		2							3	2	2	

1=weakly mapped2= moderately mapped3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**											**3**			
CO2	**3**			**3**								3			
CO3	**3**	3										3			
CO4		**3**		**3**								3	3	3	
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH311A	BIOMOLECULES	L	T	P	C
Version 3.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of reaction mechanism				
Co-requisites	--				

Course Objectives

3. To enable the students to understand biomolecules and their function in living system.
4. To provide exposure of energy molecules in living system.

Course Outcomes

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

CO1. Understand the role of nucleic acid in genetic system and differentiate nucleotide from nucleosides, DNA and RNA, replication from transcription

CO2. Appreciate the chemistry of amino acids, peptides and proteins and their methods of synthesis

CO3. Gain insights about the factors affecting enzyme's action in biochemical reactions

CO4. Differentiate the structure and functions of carbohydrates and the methods of interconversion

CO5. Evaluate the role of energy molecules in living system by studying their metabolism

CO6. Learn about importance of biomolecules in living system

Catalog Description

This course comprise of Nucleic acids and their importance in heredity as in Genetic coding. Syllabus has details Synthesis of amino acids and their role in peptide linkage to form proteins. It also provides information regarding enzymes and their role. The exposure of energy molecules in life also the important parts this syllabus.

Course Content

Unit I **15Lectures**

Nucleic Acids: Structure of components of nucleic acids: Bases, Sugars, Nucleosides and Nucleotides. Nomenclature of nucleosides and nucleotides, structure of polynucleotides (DNA and RNA), concept of DNA duplex formation and its characterization.Biological roles of DNA and RNA. Concept of heredity:Genetic Code, Replication, Transcription and Translation.

Unit II **15 Lectures**

Amino Acids, Peptides and Proteins: Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structure-end group analysis. Synthesis of peptides using N-protecting, C-protecting and C- activating groups, Solid-phase synthesis; primary, secondary and tertiary structures of proteins, Denaturation of proteins.**Enzymes:** Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes.

Mechanism of enzyme action (taking chymotrypsin as an example), factors affecting enzyme action, coenzymes and cofactors (NAD,FAD), specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance.

Unit III **15 Lectures**

Carbohydrates and lipids: Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projection and conformational structures; Interconversion of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Disaccharides – Structure elucidation of maltose,lactoseandsucrose.Polysaccharides–
Elementarytreatmentofstarch,celluloseandglycogen.

Introduction to oils and fats: common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

Unit IV **15 Lectures**

Concept of Energy in Biosystems: Introduction to metabolism (catabolism, anabolism). ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: NAD^+, FAD. Outline of catabolic pathways of carbohydrate-glycolysis, fermentation, Krebs cycle. Caloric value of food, standard caloric content of food types.

Reference Books:

1. Berg, J.M.; Tymoczko, J.L.; Stryer, L. (2006),Biochemistry. W.H. Freeman andCo.
2. Nelson, D.L.; Cox, M.M.; Lehninger, A.L.(2009),Principles of Biochemistry. W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A.; Rodwell, V.W.(2009),Harper's Illustrated Biochemistry.LangeMedicalBooks/McGraw-Hill.
4. Brown,T.A. (2018) Biochemistry, (First Indian addition 2018) VivaBooks.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the role of Nucleic acid in Genetic system.	**PO3, PSO4**
CO2	Learn about amino acids, peptides and proteins.	**PO1, PO3, PO4, PSO4**
CO3	Application of enzymes in biochemical reaction.	**PO5, PSO4**
CO4	Learn about carbohydrates and metabolism	**PO1, PO3, PSO4**
CO5	Understand the role of energy molecules in living system.	**PO3**
CO6	Learn about importance of biomolecules in living system.	**PO3**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 311A	BIOMOLECULES	2		3	1	1									

1=weakly mapped 2= moderately mapped 3=strongly mapped

Programme and Course Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO1**	**PSO 2**	**PSO3**	**PSO 4**
CO1			3												2
CO2	3		3	**3**											2
CO3			3		**3**										2
CO4	3		**3**												2
CO5			**3**												
CO6			**3**												
1=lightly mapped 2= moderately mapped 3=strongly mapped															

BSCH361A	BIOMOLECULES LABS	L	T	P	C
Version 2.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of BIOMOLECULES				
Co-requisites	--				

Course Objectives

1. To enable the student for hands on learning by experiments.
2. To generate confidence among students to perform reactions or analysis.

Course Outcomes

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

CO1. Understand the volumetric titrations.

CO2. Estimate Carbohydrate and Proteins.

CO3. Understand the action of salivary gland amylase.

CO4. Analyze the saponification number and Iodine value of lubricants.

CO5. Learn about the environment safety at the time of performing experiment.

Catalog Description

This course contains estimation of glucose and proteins, study of amylase action, analysis of Saponification number and Iodine value of oils.

Course Content **30 lecture**

1. Estimation of glucose by Fehling'ssolution.
2. Study of the titration curve ofglycine.
3. Estimation of proteins by Lowry'smethod.
4. Study of the action of salivary amylase on starch under optimumconditions.
5. Effect of temperature on the action of salivaryamylase.
6. Isolation and estimation of DNA usingcauliflower/onion.
7. Saponification value of the given oil.
8. Determination of Iodine number of the givenoil.

References books:

1. **Manual of Biochemistry Workshop**, 2012, Department of Chemistry, University ofDelhi.

2. Kumar,A.;Garg,S.;Garg,N.(2012),**BiochemicalTests:PrinciplesandProtocols**.Viva Books.

(Note: A candidate has to perform at least eight experiments in the lab. Anysuitableexperimentmay be added.)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Understand the volumetric titrations.	PO1, PSO1
CO2	Estimate Carbohydrate and Proteins.	PO5, PSO1
CO3	Understand the action of amylase.	PO4
CO4	Analyze the saponification number and Iodine value of lubricants.	PO1, PSO1
CO5	Learn about the environment safety at the time of performing experiment.	PO7

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team.	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 203A	ORGANIC CHEMISTRY-III	1			2	1		1				3			

1=weakly mapped2= moderately mapped3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1				**3**								3			
CO2					**3**							3			
CO3				**3**											
CO4	**3**											3			
CO5							**3**								
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH302A	Chemistry of Materials	L	T	P	C
Version 1.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of solid states and composite materials				
Co-requisites	--				

Course Objectives

1. To understand basic parameters of crystalline solids, symmetry and crystal structure.
2. To learn about the applications of silica-based materials.
3. To differentiate between mesoporous and microporous silica-based materials
4. To give hand on experience of sol-gel techniques for preparation of materials.

Course Outcomes

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

CO1. Learn about advanced material synthesis and material characterization.

CO2. Learn about the connections between the structure and properties of solids, including theory.

CO3. Learn to conduct chemical analyses and characterization of the physical properties of solids.

CO4. Understand about the composites and their industrial applications.

CO5. Familiar with synthesis of crystalline materials via solid state reactions.

CO6. Apply techniques for developing literacy and higher order thinking in teaching methods.

Catalog Description

his course imparts basic knowledge of crystallographic and crystal chemical concepts such as unit cell, Miller indices, close packing etc. This course introduces different types of defects in crystalline solids which are responsible for the electrical conductivity, thermal conductivity and their coloration properties. The course will provide a basic understanding of the composite materials, the role of matrix in composites and use of fibre-reinforced composites in structural applications.

Course Content

UNIT I **15 Lectures**

Basics of crystalline solids:

Crystalline solids, crystal systems, Bravais lattices, coordination number, packing factors – cubic, hexagonal, diamond structures, lattice planes, Miller indices, interplanar distances, directions, types of bonding , lattice energy, Madelung constants, Born Haber cycle, cohesive energy, Symmetryelements,operations,translationalsymmetries-pointgroups,spacegroups,equivalent positions, close packed structures, voids, crystal structures, Pauling rules, defects in crystals, polymorphism,twinning.

UNIT II **15 Lectures**

Silica based materials:

Introduction to Zeolites, metallosilicates, silicalites and related microporous materials, Mesoporous silica, metal oxides and related functionalized mesoporous materials: Covalent organic frameworks, Organic-Inorganic hybrid materials, periodic mesoporous organo silica, metal organic frameworks: H_2 /CO_2 gas storage and catalytic applications

UNIT III **15 Lectures**

Inorganic solids/ionic liquids of technological importance:

Preparation of inorganic solids: Conventional heat and beat methods, Co-precipitation method, Sol-gelmethods,Hydro-thermalmethod,Ion-exchangeandIntercalationmethods.Introductionto Solid electrolytes, inorganic liquid crystals. Ionic liquids, forces responsible for ionic liquids, synthesis and application of imidazolium and phosphonium based ionic liquids. Host-guest chemistry (elementaryideas).

UNIT IV **15 Lectures**

Composite materials:

Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.

Recommend books/References:

1. Atkins P, Overton T., Rourke J. Weller M. and Armstrong F *Shriver and Atkins. Inorganic Chemistry* Oxford University Press, Fifth Edition,2012.
2. Adam, D.M. *Inorganic Solids: An introduction to concepts in solid-state structural chemistry*. JohnWiley,1974.
3. Poole, C.P. & Owens, F.J. *Introduction to Nanotechnology* John Wiley2003.
4. Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning,2002.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Learn about advanced material synthesis and material characterization.	**PO5, PSO1**
CO2	Learn about the connections between the structure and properties of solids, including theory.	**PO2**
CO3	Learn to conduct chemical analyses and characterization of the physical properties of solids.	**PO4**
CO4	Understand about the composites and their industrial applications.	**PO1, PO4**
CO5	Familiar with synthesis of crystalline materials via solid state reactions.	**PO1, PO3**
CO6	Apply techniques for developing higher order thinking	**PO2**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach to draw a logical conclusion	Learning of fundamental concepts and instrumentation techniques decipher chemical issues	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH302A	Chemistry of Materials	2	1	1	3	3	3					1			

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1					**3**							3			
CO2		**3**													
CO3				**3**											
CO4	3			3											
CO5	3		**3**												
CO6		3				**3**									
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH352A	Chemistry of Materials Practicals	L	T	P	C
Version 1.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of resins and analytics techniques				
Co-requisites	--				

Course Objectives

1. To introduce the preparation methods of resins
2. To introduce synthesis of porous materials and nanomaterial using various techniques.
3. To learn about some analytical techniques.
4. To solve problems related to chemical analysis and interpret analytical results.
5. To provide experience in some scientific methods employed in analytical chemistry.
6. Performing risk assessment of chemical experiments and chemical analytical activity

Course Outcomes

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

CO1. Understand the basic principles involved in analytical techniques.

CO2. Learn about techniques to measure crystallinity, structure and composition of nanomaterials.

CO3. Enable how to communicate scientific information clearly and accurately, both in oral and in written forms.

CO4. Idea about the composition of written laboratory reports that summarize experimental procedures and the accurately present and interpret data.

CO5. Learn to work with others as part of a team to solve scientific problems.

CO6. Learn to find out the size of particles through different techniques.

Catalog Description

This course covers the simple synthesis method of resin using polymers, porous materials and nanomaterial using sol-gel, hydrothermal or microwave method. The course gives introduction and hand on experience of analytical techniques and an overview of important analytical methods and their range of application within detection of inorganic and organic compounds.

Course Content **30 lecture**

(The list of experiments are suggestive. However, faculties/academic bodies may add more experiments/references or incorporate suitable revisions based on infrastructure facilities available).

1. Preparation of urea-formaldehyderesin
2. Preparations of novalac resin/resolresin
3. Synthesis of materials/porous materials (Sol-gel, hydrothermal, microwave). (Similarly other materials synthesis can bedesigned).
4. Preparation of silver nano material. (Similarly other nano materials of other metals synthesis can bedesigned).

5. Analysis of XRD pattern ofcrystals.
6. Interpretation of FTIR, NMR and UV-Vis data of givenmaterial.
7. Estimation of particle size from the BET, SEM techniques.
8. Density measurement of ionicliquids
9. Determining dynamic viscosities of given ionicliquids
10. Determination of hydration number IRspectra.

(Note: A candidate has to perform at least eight experiments in the lab. Any suitable experiment may be added.)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Understand the basic principles involved in analytical techniques.	PO5, PSO1
CO2	Learn about techniques to measure crystallinity, structure and composition of nanomaterials.	PO4, PSO1
CO3	Enable how to communicate scientific information clearly and accurately, both in oral and in written forms.	PO10
CO4	Idea about the composition of written laboratory reports that summarize experimental procedures and the accurately present and interpret data.	PO6, PO5
CO5	Learn to work with others as part of a team to solve scientific problems.	PO9, PO10
CO6	Learn to find out the size of particles through different techniques.	PO1, PO4, PSO1

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles of chemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 352A	Chemistry of Materials Practical	1			2	2	1			1	2	3			

1=weakly mapped2= moderately mapped3=strongly mapped

Programme and Course Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1					**3**							3			
CO2				**3**								**3**			
CO3										**3**					
CO4					**3**	**3**									
CO5									**3**	**3**		**3**			
CO6	**3**			**3**											
1=lightly mapped 2= moderately mapped 3=strongly mapped															

DISCIPLINE SPECIFIC ELECTIVE-IV

BSCH308A	**Introduction of Nanochemistry and Applications**	L	T	P	C
Version 1.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Chemistry				
Co-requisites	--				

Course Objectives

1. To be able to understand different classifications of nanomaterials.
2. To learn the experimental methods for synthesising nanomaterials.
3. To understand characterisation techniques that can be employed to study nano dimension.
4. To develop a comprehensive knowledge about size dependent properties of nanoparticles.

Course Outcomes

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

CO1. Understand various important terms about nanochemistry.

CO2. Calculate surface to volume ratio for different shapes of nanomaterials.

CO3. Explain size dependent properties of nanomaterials.

CO4. Learn about different synthetic approaches for the preparation of nanomaterials, with examples of preparation of gold and silver nanoparticles.

CO5. Remember several different types of instrumentation for characterising nanoparticles.

CO6. Understand the use of nanomaterials in environmental remediation and biology.

Catalogue Description

This course imparts the basic concepts of nanotechnology. It enables the students to understand the idea of synthesis and structural aspects of different types of nanomaterials. The course of nanochemistry will impart the knowledge about different characterisation techniques for nanomaterials. The course also introduces the use of nanoparticles in environmental remediation and biology.

Course Content

Unit I: 15 Lectures

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

Unit II: **15 Lectures**

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 III: **15 Lectures**

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- control of nanoarchitecture- one dimensional control. Carbon nanotubes and inorganic nanowires.

Unit IV: **15 Lectures**

Material characterization techniques (basic idea of use of following instruments in nanomaterialcharacterizationneedtobeemphasized):Electronmicroscopictechnique,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 bediscussed).

Text Books

1. C.N.R.Rao,A.Muller,A.K.Cheetam,TheChemistryofNanomaterials:Synthesis,Properties and Applications, Willey-VCH Verlag, Germany,2005.
2. G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press, London, 2004

Reference Books/Materials

1. R. W. Kelsall, I. W. Hameley, M. Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, England, 2005
2. CharlesP.PooleandFrankJOwens,*Introductiontonanotechnology*,WileyInterscience,2003.
3. Pradeep, T., A text of book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi,2012.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand various important terms about nano chemistry	**PO1**
CO2	Calculate surface to volume ratio for different shapes of nanomaterials.	**PO2, PSO3**
CO3	Explain size dependent properties of nanomaterials.	**PO1, PSO1**
CO4	Learn about different synthetic approaches for the preparation of nanomaterials, with examples of preparation of gold and silver nanoparticles.	**PO1, PO5**
CO5	Remember several different types of instrumentation for characterizing nanoparticles.	**PO1, PO4**
CO6	Understand the use of nanomaterials in environmental remediation and biology.	**PSO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH308A	Introduction of Nanochemistry and Applications	3	1		1	1						1		1	1

1= weakly mapped 2= moderately mapped 3= strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**														
CO2		**3**												**3**	
CO3	**3**											**3**			
CO4	**3**				**3**										
CO5				**3**											
CO6															**3**
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH368A	Introduction of Nanochemistry and Applications Practicals	L	T	P	C
Version 1.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of Chemistry				
Co-requisites	--				

Course Objectives

1. To be familiarize with common instruments and glasswares used in nanoparticles synthesis.
2. To fabricate zinc oxide and silver nanoparticles.
3. To confirm the successful synthesis of the mentioned particles with the help of absorbance values.
4. To learn and verify Beer-Lambert law.

Course Outcomes

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

CO1. Synthesise zinc oxide nanoparticles.

CO2. Synthesise silver nanoparticles.

CO3. Characterise the nanoparticles with the help of absorbance peak.

CO4. Use instruments like magnetic stirrers used in synthesis.

CO5. Record absorbance values using instruments like colorimeter or UV spectrophotometer.

CO6. Derive and verify Beer-Lambert law.

Catalogue Description

This course imparts the basic understanding of nanoparticles synthesis. It enables the students to synthesise nanoparticles like zinc oxide and silver nanoparticles. The course also introduces the Beer-Lambert law, and its verification with the help of either a colorimeter or a UV spectrophotometer.

Course Content **30 lecture**

List of Experiments

1. Synthesis of ZnO nanoparticles.
2. Preparation of Silvernanoparticles.

(diverse nanoparticles can be prepared by various routes)

3. Verification of Beer-Lambert law using nano-particles (above prepared nano-particles may be used for thestudy).

(Dependinguponheavailabilityofinfrastructurefacilities,instructormayencouragethestudents topreparebimetallicnano-particles,etc.andcharacterizedthem,studytheirvariouspropertieslike magnetism, adsorption,etc.)

Recommended/Reference Books

1. Pradeep T., A text book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012 edition.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes/ Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and Pos		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Synthesise zinc oxide nanoparticles.	PO5
CO2	Synthesise silver nanoparticles.	PO5
CO3	Characterise the nanoparticles with the help of absorbance peak.	PO5, PO4
CO4	Use instruments like magnetic stirrers used in synthesis.	PO1, PO5, PSO2
CO5	Record absorbance values using instruments like colorimeter or UV spectrophotometer.	PO2, PO4, PSO1, PO6
CO6	Derive and verify Beer-Lambert law.	PO1, PO4, PO6

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH368A	Introduction of Nanochemistry and Applications Practicals	1	2		3	3	2					1	1		

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1					3										
CO2					3										
CO3				3	3										
CO4		3			3								3		
CO5		3		3		3						3			
CO6	3			3		3									
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH310A	Green Processes of Chemistry	L	T	P	C
Version 2.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	12^{th} level Chemistry				
Co-requisites	--				

Course Objectives

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

1. Green chemistry and itsprinciples and processes in laboratoryreactions.
2. Green synthesis and reactions.
3. Green chemistry for sustainablesolutions.
4. Principles of green chemistry.
5. Design of chemical reactions/chemical synthesis using green chemistry principles.

Course Outcomes

By the end of this course, students will be able to:

CO1: Understand the twelve principles of green chemistry and will build the basic understanding of toxicity, hazard and risk associated with chemicalsubstances.

CO2: Understand stoichiometric calculations and relate them to green chemistry metrics. They will learn about atom economy and how it is different from percentageyield.

CO3: Learn to design safer chemical, products and processes that are less toxic than current alternatives. Hence, they will understand the meaning of inherently safer design for accident prevention and the principle "what you don't have can't harmyou"

CO4: Understand benefits of use of catalyst and bio catalyst, use of renewable feed stock which helps in energy efficiency and protection of environment, renewable energy sources, and importance of reactions in various greensolvents.

CO5: Appreciate the use of green chemistry reactions in problem solving skills, critical thinking and valuable skills to innovate and find out solution to environmental problems. Thus the students are able to realize that chemistry can be used to solve rather than cause environmentalproblems.

CO6: Analyze the green methods to increase productivity and ensure sustainability with absolute zero waste.

Catalog Description

Climate change and degradation of environment is a common global issue and sustainable development goals emphasize on reduction in pollution so as ensure better health, better sanitation and clean environment for all. Chemicals released from different industries as well as from chemical/ pharmaceutical labs add on to contaminants concentration in the environment. It is imperative to teach students the philosophy of green chemistry and how it can be helpful to reduce environmental pollution. Success stories and real world cases also motivate them to practice green chemistry. These days customers are demanding to know about a product: Is it green? Does it contribute to global warming? Was it made from non-renewable resources?

Students have many career opportunities as " green" is the path to success.

Course Content

UNIT I

Introduction to Green Chemistry **10 Lectures**

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

UNIT II

PrinciplesofGreenChemistryandDesigningaChemicalsynthesis **20 Lectures**

TwelveprinciplesofGreenChemistrywiththeirexplanationsandexamplesandspecialemphasis 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 eliminationreactions).

UNIT III

Green Synthesis / Reactions **15 Lectures**

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

1. Microwaveassistedreactionsinwater:(HofmannElimination,methylbenzoatetobenzoicacid, oxidation of toluene and alcohols) and reactions in organic solvents (Diels-Alder reaction and Decarboxylationreaction).
2. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative toIodine)
3. Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning ofgarments.
4. Designing of Environmentally safe marineantifoulant.
5. An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made fromcorn.
6. Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of no Trans-Fats andOils

UNIT IV

Future Trends in Green Chemistry **15 Lectures**

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solvent less reactions; co crystal controlled solid state synthesis(C_2S_3); Green chemistry in sustainabledevelopment.

Recommended Books/References:

1. Ahluwalia,V.K.,Kidwai,M.R.*NewTrendsinGreenChemistry*,AnamalayaPublishers(2005).
2. Anastas,P.T.&Warner,J.K,*GreenChemistry-TheoryandPractical*,OxfordUniversityPress (1998).
3. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker(2001).
4. Cann, M.C.and Connely, 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.

odes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Learning Outcomes (PLOs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the twelve principles of green chemistry and will build the basic understanding of toxicity, hazard and risk of chemicalsubstances.	**PO1, PSO1**
CO2	Understand stoichiometric calculations and relate them to green chemistry metrics. They will learn about atom economy and how it	**PO1**
CO3	Learn to design safer chemical, products and processes that are less toxic, than current alternatives. Hence, they will understand the	**PO7, PSO1,**
CO4	Understand benefits of use of catalyst and bio catalyst, use of renewable feed stock which helps in energy efficiency and	**PO7, PSO4**
CO5	Appreciate the use of green chemistry reactions in problem solving skills, critical thinking, and valuable skills to innovate and find out	**PO2, PO7, PSO4**
CO6	Analyze the green methods to increase productivity and ensure sustainability with absolute zero waste.	**PO7, PSO4**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 310A	**Green Processes of Chemistry**	3	1					3				2			2

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**											3			
CO2	**3**														
CO3							**3**					3			
CO4							**3**								3
CO5		**3**					**3**								3
CO6							**3**								3
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH360A	Green Processes of Chemistry Practicals	L	T	P	C
Version 2.0		4	0	0	4
Total Contact Hours	30				
Pre-requisites/Exposure	12^{th} level Chemistry				
Co-requisites	--				

Course Objectives

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

1. Green chemistry and itsprinciples and processes in laboratoryreactions.
2. Green solvent/ solvent less reactions.
3. Design of chemical reactions/chemical synthesis using green chemistry principles.
4. Concept of atom economy, catalysts.

Course Outcomes

By the end of this course, students will be able to:

CO1: Understand the twelve principles of green chemistry

CO2: Understand stoichiometric calculations, atom economy and relate them to green chemistry metrics.

CO3: Learn to design safer chemical, products and processes by using green solvents, catalyst, energy efficient processes etc.

CO4: Understand benefits of use of catalyst and bio catalyst, which not only helps in increase in yield but also protects the environment by less usage of reactants.

Catalog Description

It is very important to learn new processes and synthetic tools to prepare novel compounds by doing either solvent less reactions or green solvents or performing reactions in microwaves or sonicatorsso as to promote sustainability. The techniques learnt in laboratories will help students to create/innovate/synthesize new processes and products.

Course Content **30 lecture**

(Following is the list of suggestive experiments. However, depending upon available resources, experiments may be added/changes may be incorporated): (six experiments may be conducted)

1. Preparation and characterization of nanoparticles of gold using tealeaves.
2. Preparation of biodiesel from vegetable/ waste cookingoil.
3. Use of molecular model kit to stimulate the reaction to investigate how the atom economy illustrates GreenChemistry.
4. Reactionslikeaddition,elimination,substitutionandrearrangementmayalsobestudiedforth e calculation of atomeconomy.
5. Benzoin condensation using Thiamine Hydrochloride as a catalyst (instead ofcyanide).
6. Extraction of D-limonene from orange peel using liquid CO_2 prepared form dryice.
7. Mechanochemical solvent free synthesis ofazomethines
8. Solvent free, microwave assisted one pot synthesis of phthalocyanine Cu(II)complex.
9. Photoreduction of benzophenone to benzopinacol in presence ofsunlight.

Recommended Books/References:

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.andThomas,P.*RealworldcasesinGreenChemistry,*AmericanChemicalSociety (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.

(Note: A candidate has to perform at least eight experiments in the lab. Anysuitableexperimentmaybeadded.)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Lab Record/Quizzes / Viva-Voce	Attendance	End Term PracticalExamination
Weightage (%)	20	20	10	50

Relationship between the Course Outcomes (COs) and Program Learning Outcomes (PLOs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the twelve principles of green chemistry.	**PO1, PO7, PSO1,**
CO2	Understand stoichiometric calculations, atom economy and relate them to green chemistry metrics.	**PO1, PO7, PSO1, PSO4**
CO3	Learn to design safer chemical, products and processes by using green solvents, catalyst, energy efficient processes etc.	**PO1, PO7, PSO1,**
CO4	Understand benefits of use of catalyst and bio catalyst, which not only helps in increase in yield but also protects the environment by less usage of reactants.	**PO1, PO7, PSO1,**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 360A	**Green Processes of Chemistry Practicals**	3						3				3			1

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**						**3**					3			
CO2	**3**						**3**					3			1
CO3	**3**						**3**					3			
CO4	**3**						**3**					3			
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

SCH332A	Polymer Chemistry	L	T	P	C
Version 1.0		3	1	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Chemistry				
Co-requisites	--				

Course Objectives

1. To use essential descriptions about polymer chemistry, and define related concepts.
2. To evaluate the structure and molecular weight of polymers.
3. To learn and interpret stereochemistry of polymerization.
4. To learn about modern techniques that could be used to identify and characterize any give given polymer.

Course Outcomes

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

CO1. Understand the meaning of polymer and different important terms related to it.

CO2. Explain the kinetics of addition polymerization.

CO3. Learn polymeric structure and property relationship.

CO4. Appreciate the industrial aspects and applications of several different polymers.

CO5. Understand how to determine molecular weight of a given polymer by using several experimental techniques.

CO6. Learn how to identify a given polymer with the help of spectroscopic techniques.

Catalogue Description

The topics included in this course will help students to study the classification and properties related to the polymers. They will learn about polymeric structure and property relationship. They will also study about the different types of molecular weights and their distribution. It will enable them to understand stereochemistry of polymerisation reactions. The course discusses various experimental techniques to identify and characterize polymers. This course also includes detailed study of kinetics and mechanism of the polymerisation process and uses of polymers.

Course Content

Unit I: **15 Lectures**

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

Unit II: **15 Lectures**

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, polydispersityindex,crystallinityinpolymer,meltingtemperatureandglasstransitiontemperature, 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: **15 Lectures**

Polymerization Chemistry: Industrial methods of polymerization such as a bulk, solution, emulsion, suspension. Stereochemistryofpolymersandstereo-specificpolymerization,Catalysts-theirutilityinpolymers and stereo-specific polymerizations, Catalysts their utility in polymer manufacture, Zieglar-Natta, Metallocene and others.

Unit IV: **15 Lectures**

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 ofpolymers.

Text Books

1. D.W. Van Krevelen and P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition ElsevierScientific, 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

Reference Books/Materials

1. Odian; George, Principles of Polymerization, McGraw-Hill Book Co., New York(1970).
2. W. Billmeyer, Text book of polymer science, 3rdEdn., 2007,Wiley.
3. J.R.Fried, Polymer Science and Technology, (2005), PHIpublication.
4. Billmeyer Jr.; Fred W., Textbook of Polymer Science, Wiley- Interscience Publishers, New York (1962).

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz/Assignment	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the meaning of polymer and different important terms related to it.	**PO1**
CO2	Explain the kinetics of addition polymerization.	**PO1, PSO1**
CO3	Learn polymeric structure and property relationship.	**PO2**
CO4	Appreciate the industrial aspects and applications of several different polymers.	**PSO1, PO5**
CO5	Understand how to determine molecular weight of a given polymer by using several experimental techniques.	**PSO1, PO1**
CO6	Learn how to identify a given polymer with the help of spectroscopic techniques.	**PO4, PSO2**

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH332A	Polymer Chemistry	3	2		2	2						3	2		

1=weakly mapped 2= moderately mapped 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**														
CO2	**3**											**3**			
CO3	**3**	**3**													
CO4					**3**							**3**			
CO5	**3**											**3**			
CO6				**3**									**3**		
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH372A	Polymer Chemistry Practicals	L	T	P	C
Version 1.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of Chemistry				
Co-requisites	--				

Course Objectives

1. To learn the necessary calculations to get the viscosity value from the time of flow.
2. To carry out free radical solution polymerisation reactions.
3. To understand the theory and protocol of emulsion polymerization.
4. To observe and learn common characterizing techniques for polymers.

Course Outcomes

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

CO1. Learn to use Ostwald's viscometer.

CO2. Explain free radical solution polymerization.

CO3. Perform preparation of phenol-formaldehyde resins.

CO4. Understand the bisulphite method to estimate the amount of HCHO in any given solution.

CO5. Learn the working principle of spectroscopic techniques like, FTIR, TGA, and DSC.

CO6. Understand and determine exchange capacity of cation-exchange and anion-exchange resins.

Catalogue Description

This course imparts the basic experiments related to the field of polymer chemistry. It enables the students to calculate the molecular weight of any given polymer. The course helps them in understanding different types of polymerization, like free radical and emulsion polymerization. The course introduces the basic concepts about resins, their synthesis and the determination of their exchange capacities.

Course Content 30 lecture

List of Experiments

1. Free radical solution polymerization of any one: Styrene, methylmethacrylate, methyl acrylate, methacrylic acid (using free radical initiators). (purification of monomer should be taught)
2. Preparation of phenol-formaldehyde resins
3. Emulsion polymerization of polymethylmethacrylate.
4. Use of viscometer for molecular weight determination – (any known polymer, example: polyvinyl pyrrolidone in water/polyacrylamide in $NaNO_2$solution) by viscometry. (students should be explained regarding principles and use of ubblohde/ostwald viscometer).

5. Estimation of amount of HCHO in a given solution by sodium bisulphite method.
6. Use of FTIR/TGA/DSC – for polymer characterization (may be demonstrated to students)
7. Determination of exchange capacity of cation exchange resins and anion exchange resins.

Recommended Books/Reference books

1.P. Munk & T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed. John Wiley & Sons (2002).
2.M.P. Stevens, *Polymer Chemistry: An Introduction* 3rd ed. Oxford University Press (2005).
3. L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley &Sons(2005)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Conduct of Experiment**	**Lab Record/Quizzes / Viva-Voce**	**Attendance**	**End Term PracticalExamination**
Weightage (%)	**20**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Learn to use instruments for viscosity measurements	**PO4, PO6, PSO1**
CO2	Explain free radical solution polymerization.	**PO1**
CO3	Perform preparation of phenol-formaldehyde resins.	**PO2, PO6, PSO1**
CO4	Understand the bisulphite method to estimate the amount of HCHO in any given solution.	**PO6, PO1, PSO2**
CO5	Learn the working principle of spectroscopic techniques like, FTIR, TGA, and DSC.	**PO1, PO4, PO6**
CO6	Understand and determine exchange capacity of cation-exchange and anion-exchange resins.	PO1, PSO1

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH372A	Polymer Chemistry Practicals	3	2		2		3					2	2		

1=weakly mapped2= moderately mapped3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1				**3**		**3**									
CO2	**3**														
CO3		**3**				**3**									
CO4	**3**					**3**							**3**		
CO5	**3**			**3**		**3**									
CO6	**3**											**3**			
	1=lightly mapped 2= moderately mapped 3=strongly mapped														

BSCH358A	Research Project	L	T	P	C
Version 1.0		0	0	2	6
Pre-requisites/Exposure	Practical exposure				
Co-requisites	--				

Course Objectives

5. To learn how to carry out literature survey
6. To be associated with an area of research/research project and contribute towards domain knowledge.
7. To learn the art of technical report writing
8. To learn the art of verbal communication with the help of modern presentation techniques.

Course Outcomes

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

CO1. Carry out the extensive literature survey.

CO2. Learn to write and present technical reports/articles.

CO3. Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.

CO4. Learn to analyze/evaluate the result of the experiment carried out and present the results using data visualization methods.

Catalog Description

1. Students will be divided among faculty members of the Department for the supervision of the research work.
2. In the first week of Semester V, each faculty member will assign a suitable research topic to the students from the selected topics in the areas of chemical sciences.
3. The student will work on the assigned research topic during semesters V and VI in regular consultation with his/her assigned teacher.
4. The student will write a dissertation based on the research work carried out during Semesters V and VI and prepare two copies to be submitted to the office of the Head of the Department duly signed by the student and the supervisor in the sixth week of VI semester or a date decided by the HOD of the department.
5. Before preparing power point presentation and submission of dissertation, each student has to deliver a seminar talk on his/ her research project work on a date fixed by HOD, necessary suggestions has to be incorporated in the final draft of dissertation.
6. The student will make a power point presentation based on the work carried out and mentioned in the dissertation to the board of examiners appointed by the University.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Internal (Interaction of Student with Supervisor)	External			Total
		Relevance of topic (20)	Presentation (20)	viva (10)	100
Weightage (%)	50	20	20	10	

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Carry out the extensive literature survey.	PO1, PO3
CO2	Learn to write and present technical reports/articles.	PO1, PO5, PO8, PO9
CO3	Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.	PO2,PO3,PO4, PSO1, PSO4
CO4	Learn to analyze/evaluate the result of the experiment carried out and present the results using data visualization methods.	PO5, PO6,PSO2 and PSO3

		Enhancement in Advanced Scientific knowledge about chemistry	Development of critical, logical and innovative thinking	Demonstrate interdisciplinary approach	Learning of fundamental concepts and instrumentation techniques	Orientation towards research and development	Acquiring capability to work independently as well as a member of the diverse team	Understanding of impact of chemicals on the environment	Fostering communication skills	Ethical awareness and digital literacy	Capability to deal with professional responsibilities	Systematic and coherent understanding of theoretical and practical concepts	Appreciate the techniques for the qualitative and quantitative analysis	Learn problem solving approach	Apply principles ofchemistry to address societal problems
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
BSCH 358A	Research Project	3	3	3	3	3	3		3	3		3	2	3	3

1=weakly mapped; 2= moderately mapped; 3=strongly mapped

	Programme and Course Mapping														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**
CO1	**3**		**3**												
CO2	**3**				**3**			**3**	**3**						
CO3		**3**	**3**	**3**								**3**			**3**
CO4					**3**	**3**							**2**	**3**	
	1=lightly mapped 2= moderately mapped 3=strongly mapped														