K.R. MANGALAM UNIVERSITY

THE COMPLETE WORLD OF EDUCATION

SCHOOL OF BASIC AND APPLIED SCIENCES

Master of Science Chemistry
M.Sc. Chemistry

Programme Code: 68

2021-2023

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

August 2021

Academic Council
Member Secretary
K.R. Mangalam University

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

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PREAMBLE

The objective of any programme at 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 Post-Graduate courses. The credit system to be implemented through this curriculum, would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities. The students pursuing this course would have to develop in depth understanding of various aspects of the subject. The conceptual understanding, development of experimental skills, designing and implementation of novel synthetic methods, developing the aptitude for academic and professional skills, research skills, acquiring basic concepts for structural elucidation with hyphenated techniques, understanding the fundamental biological processes and rationale towards computer assisted drug designing are among such important aspects.

Prepared by:

Dr. Meena Bhandari	Dr Seema Raj	Dr Chandra Mohan	Dr Neeraj Kumari
Associate Professor	Assistant Professor	Assistant Professor	Assistant Professor

Dr Sona Gandhi
Assistant Professor

Verified by: Approved by:

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 various Undergraduate, Postgraduate and Doctoral Degree programs across different disciplines. The group of educational units in the University promote 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.

The School comprises of Department of Chemistry, Physics and Mathematics.

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 to provide theoretical as well as practical training in their respective fields.

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.

4. M.Sc. Chemistry

This programme 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 B.Sc. (Hons.) / B.Sc. with Chemistry as a major subject, from a recognized University or equivalent with minimum 50% marks in aggregate.

Course Outline:- Amalgamation of advance subjects of Inorganic/ Organic/ Physical Chemistry.

Career Options:- Opportunities exist in natural product industry, chemical industry, pharmacy, education and forensics etc

Program Educational Objectives (PEOs)

PEO 1: Graduates will possess advanced knowledge and expertise in various sub-disciplines of chemistry.

PEO 2: Graduates will develop strong research and problem-solving skills to investigate complex chemical problems.

PEO 3: Graduates will have the technical competence to apply their knowledge in practical settings using modern laboratory techniques and instrumentation.

PEO4: Graduates will effectively communicate scientific concepts and collaborate in multidisciplinary teams.

PEO 5: Graduates will adhere to high ethical standards and professional conduct in their scientific endeavors.

PEO 6: Graduates will commit to lifelong learning, staying updated with advancements in the field of chemistry.

PEO 7: Graduates will demonstrate leadership skills and have the potential for career advancement in academia, industry, or other scientific organizations.

Programme Outcomes (POs)
PO1: Apply knowledge of chemistry to become proficient teacher
PO2: Identify and resolve complex scientific research problems

PO3: Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion
PO4: Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues
PO5: Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices
PO6: Adopt green chemistry tools for sustainable development
PO7: Follow the ethical principles and responsibilities of a chemist to serve the society
PO8: Effective communication and presentation of data/project reports
PO9: Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings
PO10: Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.

Programme Specific Outcomes (PSOs)
PSO1: Advanced knowledge of all aspects of chemistry
PSO2: Understand complex chemical structures, instrumentation and separation techniques
PSO3: Appreciate the importance and applications of various chemicals in day today life
PSO4: Global level research opportunities
PSO5: Enormous job opportunities in chemical, pharmaceutical, food product, and other industries

5. Programme Duration

The minimum period required for the M.Sc. Programme offered by the University shall extend over a period of two Academic Years.

The maximum period for the completion of the M.Sc. Programme offered by the University shall be four 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 M.Sc. Chemistry offered by SBAS with scheme of studies are given in the following pages.

M.Sc. Chemistry Programme at a Glance

SEMESTER	I	II	III	IV	TOTAL
COURSES	7	8	6	5	**26**
CREDITS	22	23	18	24	**87**

Scheme of Studies as per Choice-Based Credit System and Learning Outcome-Based Curriculum Framework

SEMESTER I						
S.No.	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	BSCH707A	CHEMISTRY OF D AND F-BLOCK ELEMENTS AND BIOINORGANIC CHEMISTRY	4	0	0	4
2	BSCH703	STEREOCHEMISTRY, REACTION MECHANISMS AND INTERMEDIATES	4	0	0	4
3	BSCH705	THERMODYNAMICS AND ELECTROCHEMISTRY	4	0	0	4
4	BSMA715	MATHEMATICS	4	0	0	4
5	BSCH751	INORGANIC CHEMISTRY-I LAB	0	0	4	2
6	BSCH753	ORGANIC CHEMISTRY-I LAB	0	0	4	2
7	BSCH755	PHYSICAL CHEMISTRY-I LAB	0	0	4	2
TOTAL			**16**	**0**	**12**	**22**

SEMESTER II						
S.No.	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	BSCH708	BORANES, SILICATES AND ORGANOMETALLIC COMPOUNDS	4	0	0	4
2	BSCH704	SPECTROSCOPY OF ORGANIC COMPOUNDS	4	0	0	4
3	BSCH706	QUANTUM CHEMISTRY AND CHEMICAL KINETICS	4	0	0	4
4	BSCS714	COMPUTER APPLICATIONS IN CHEMISTRY	4	0	0	4
5	**BSCH756**	INORGANIC CHEMISTRY-II LAB	0	0	4	2
6	BSCH754	ORGANIC CHEMISTRY-II LAB	0	0	4	2
7	**BSCH752**	PHYSICAL CHEMISTRY-II LAB	0	0	4	2
8	BSCS762	COMPUTER APPLICATIONS IN CHEMISTRY LAB	0	0	2	1
TOTAL			**16**	**0**	**14**	**23**

SEMESTER III						
S.No.	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	BSCH807	CO-ORDINATION CHEMISTRY AND INORGANIC POLYMER CHEMISTRY	4	0	0	4
2	BSCH803	HETEROCYCLIC, PHOTOCHEMISTRY AND PERICYCLIC CHEMISTRY	4	0	0	4
3	BSCH805	POLYMERS	4	0	0	4
4	BSCH851	INORGANIC CHEMISTRY-III LAB	0	0	4	2
5	BSCH853	ORGANIC CHEMISTRY-III LAB	0	0	4	2
6	BSCH855	PHYSICAL CHEMISTRY-III LAB	0	0	4	2
TOTAL			**12**	**0**	**12**	**18**

SEMESTER IV						
S.No.	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1		ELECTIVE	4	0	0	4
2		ELECTIVE	4	0	0	4
3		ELECTIVE	4	0	0	4
4		ELECTIVE	4	0	0	4
5	BSCH858	DISSERTATION	0	0	0	8
TOTAL			**16**	**0**	**0**	**24**

ELECTIVES OF SEMESTER IV						
S.No.	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	BSCH802	CHEMISTRY OF MATERIALS	4	0	0	4
2	BSCH804	ADVANCED ORGANIC SYNTHESIS	4	0	0	4
3	BSCH806	BIOPHYSICAL CHEMISTRY	4	0	0	4
4	BSCH808	ANALYTICAL TECHNIQUES	4	0	0	4
5	BSCH810	MEDICINAL CHEMISTRY	4	0	0	4
6	BSCH812	NUCLEAR CHEMISTRY & PHOTOCHEMISTRY	4	0	0	4
7	BSCH814	BIO-INORGANIC AND SUPRAMOLECULAR CHEMISTRY	4	0	0	4
8	BSCH816	CHEMISTRY OF LIFE PROCESSES	4	0	0	4
9	BSCH818	NANOCHEMISTRY	4	0	0	4
10	BSCH820	GROUP THEORY & SPECTROSCOPY	4	0	0	4
11	BSCH822	NATURAL PRODUCT CHEMISTRY	4	0	0	4
12	BSCH824	SOLID STATE CHEMISTRY	4	0	0	4

SEMESTER I

BSCH707A	Chemistry of d and f-block elements and Bioinorganic Chemistry	L	T	P	C
Version 2.0		4	0	0	4
Total Contact Hours	**60**				
Pre-requisites/Exposure	Basics of Transition and inner transition elements				
Co-requisites	--				

Course Objectives

1. To learn the students about the properties and compounds of transition elements
2. To learn the students various concepts of electronic spectra and magnetic properties of transition complexes
3. To enable the students competently matters of separation and applications of lanthanides and actinides.
4. To provide students with a general overview of the many very fundamental tasks performed by inorganic elements in living organisms.

Course Outcomes

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

CO1. Study the chemical, electronic and magnetic properties of transition elements.

CO2. Study the configuration and concept related to separation and uses of f- block elements.

CO3. General characteristics of Lanthanides and Actinides

CO4. Learn to know the structures and applications of Lanthanides and Actinides.

CO5. Acquire complete knowledge to draw the Orgel and T-S diagram.

CO6. Able to interpret the concepts of coordination chemistry in biological environments, and to utilizes this knowledge to analyze the influence of such an environment on the reactivity of a metal centre.

Catalog Description

In this course students will learn and understand the general information about the transition and inner transition elements, their characteristic properties, electronic and magnetic behavior and will be able to draw the orgal energy level diagram for d and f block elements. This course also helps them to get idea about the applications and to determine the term symbols for d and f block elements. This will also provide stereochemical information and separation methods.

Course Content

Unit I: Chemistry of transition elements **14 Lectures**

General characteristic properties of transition elements, co-ordination chemistry of transition metal ions, stereochemistry of coordination compounds, ligand field theory, splitting of d orbitals in low symmetry environments, John- Teller effect, Interpretation of electronic spectra including charge transfer spectra, spectrochemical series, nephelauxetic series, metal clusters, sandwich compounds, metal carbonyls.

Unit II: Electronic Spectra and Magnetic Properties of Transition Metal Complexes :**16 Lectures**

Types of electronic transition, selection rule of d-d transition, Spectroscopic ground states, correlation, Orgel energy level and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), Calculation of Dq, B and β parameters, Charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Unit III: General characteristics of Lanthanides and Actinides: **16 Lectures**

Lanthanide contraction and its consequences, Term symbols for Lanthanide ions, Factors that mitigate against the formation of lanthanide complexes, Electronic spectra and magnetic properties of lanthanide complexes, Lanthanide complexes as shift reagents, Difference between 4f and 5f orbitals, Spectral and magnetic properties, use of lanthanide compounds as shift reagents, Modern methods of separation of lanthanides and actinides.

Unit IV: Bioinorganic Chemistry **14 Lectures**

Role of alkali and alkaline earth metal ions in biology; Na+ -K + -Pump, ionophores and crown ethers. Metal site structure, function. Metal ion transport and storage: Ferritin, Transferrin, Siderophores and metallothionein. Electron Transfer: Cytochromes, Iron-Sulfur Proteins and Copper Proteins. Oxygen transport and storage: Hemoglobin, myoglobin, hemerythrin, hemocyanin. Other metal containing enzymes: Catalase, peroxidase, superoxide dismutase, alcohol dehydrogenase, carbonic anhydrase, carboxypeptidase, xanthine oxidase, nitrogenase, vitamin B12 coenzyme.

Text Books

1. J D Lee, Concise Inorganic Chemistry (ELBS with Chapman and Hall, London)
2. Jones , Elementary coordination Chemistry (Prentice-Hall)
3. R S Drago, Physical Methods in Inorganic Chemistry (International Edn. (1971), Affiliated East-West Press, New Delhi)
4. Williams, an Introduction to Bioinorganic Chemistry (C.C. Thomos Spring III)
5. Eichhorn, Inorganic Biochemistry: Vol I , 2 (Elsevier)

Reference Books/Materials

1. F A Cotton, R G Wilkinson. Advanced Inorganic chemistry(John Wiley & Sons)
2. Willam L Jooly, Modern Inorganic Chemistry(McGraw-Hill Inc.,US)
3. N. N. Greenwood and A. Earnshaw, Chemistry of elements (Pergamon)
4. John Wulff, structure and properties of materials, vol – 4, electronic properties (Wiley Eastern)
5. J Jones Chris, d- and f- Block Chemistry (Wiely Interscience & RSC)
6. Ochiai, Bioinorganic Chemistry (Allyn & Bacon Burton)
7. Ahuja, Chemical Analysis of the Environment (Plenum press)

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	Study the chemical, electronic and magnetic properties of transition elements.	PO1
CO2	Study the configuration and concept related to separation and uses of f- block elements.	PO2
CO3	General characteristics of Lanthanides and Actinides	PO1
CO4	Learn to know the structures and applications of Lanthanides and Actinides.	PO4
CO5	Acquire complete knowledge to draw the Orgel and T-S diagram.	PO3
CO6	Able to interpret the concepts of coordination chemistry in biological environments, and to utilizes this knowledge to analyze the influence of such an environment on the reactivity of a metal centre.	PO4

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH707A	**Chemistry of d and f-block elements and Bioinorganic Chemistry**	3	2	2	3				2	2		3	3	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2	**3**														
CO3	**3**														
CO4	**3**														
CO5		**3**													
CO6		**3**													

BSCH 703	STEREOCHEMISTRY, REACTION MECHANISMS AND INTERMEDIATES	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	**60**				
Pre-requisites/Exposure	Basics of reaction mechanism				
Co-requisites	--				

Course objective: In this course students will be exposed to

1. The concept of optical and geometrical isomerism's of different organic compounds.
2. The concept of reaction intermediates and their formation in different organic reactions

Course Outcomes

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

CO1. Understand the stereochemistry of organic compounds.
CO2. Analyze different configuration for the nomenclature of organic compounds.
CO3. Understand regarding geometrical isomerism.
CO4. Understand variety of conformational isomer
CO5. Learn about the reaction mechanism.
CO6. Understand the role of reaction intermediates.

Catalog Description

This course is a bunch of organic chemistry basics. In this course stereochemistry of organic compounds, geometrical isomerism and conformations are available. This course also have details of reaction mechanism with reaction intermediates.

Course Content

Unit I: Stereochemistry **16 Lectures**

Definition and classification into optical and geometrical isomerism; Projection formulae: Fischer, flying wedge, sawhorse and Newman projection formulae; Notation of optical isomers: D-L notation, Cahn-Ingold-Prelog rules, R-S notations for optical isomers with one and two asymmetric carbon atoms, erythro and threo representations.

Optical isomerism: optical activity, optical and specific rotations ; Conditions for optical activity: Asymmetric centre , chirality , achiral molecules, meaning of (+) and (-),elements of symmetry; Racemisation: Methods of racemisation (by substitution and tautomerism); Resolution: Methods of resolution (mechanical, seeding, biochemical and conversion to diastereoisomers) ; Asymmetric synthesis (partial and absolute synthesis); Optical activity in compounds not containing asymmetric carbon atoms- Biphenyls.

Unit II: Geometrical isomerism 14 Lectures

Geometrical isomerism : cis-trans, syn-anti and E-Z notations ;Geometrical isomerism in maleic and fumaric acids and unsymmetrical ketoximes; Methods of distinguishing geometrical isomers using melting point, dipole moment, dehydration and cyclisation.

Conformational analysis: Introduction of terms - conformers, configuration, dihedral angle, torsional strain; Conformational analysis of ethane and n-butane including energy diagrams ; Conformers of cyclohexane (chair, boat and skew boat forms) ; Bonds-ring flipping showing axial equatorial interconversions; Conformation of methyl cyclohexane.

Unit III: Reaction Mechanism and Reactive Intermediates-I 16 Lectures

A review of reaction mechanism including methods of determination. Linear free energy relationships and their applications (Hammett equation and modification)

Carbocations: Classical and non-classical, neighbouring group participation, ion-pairs, molecular rearrangements in acyclic, monocyclic and bicyclic systems, stability and reactivity of bridge- head carbcations.

Carboanions: Generation, structure and stability, ambient ions and their general reactions; HSAB principle and its applications.

Unit IV: Reaction Mechanism and Reactive Intermediates-II 14 Lectures

Carbenes: Stability, structure and spin states of carbenes; Cyclopropanation – spin dependence and stereochemistry; Carbene insertion to C-H bonds; Rearrangement to alkenes; Wolff rearrangement of acylcarbenes and its synthetic applications.

Nitrenes: Stability, structure and spin states of nitrenes; C-H bond insertions and aziridine formation; Rearrangement of acylnitrenes (Hoffmann, Curtius and Schmidt reactions with applications in organic synthesis).

Free Radicals: Stability and fate of organic free radicals; Metal-induced radical reactions; Radical cyclisation and coupling reactions; Addition to multiple bonds; Aromatic substitution by radicals; Allylic bromination by N- bromosuccinamide and decarboxylative bromination; Mechanism of radical reactions.

Textbooks:

1. E L Eliel, Stereochemistry of Carbon compounds (Textbook Publishers)
2. P. S. Kalsi, Stereochemistry and Mechanism through solved problems (New Age publishers)

Reference Books:

1. F A Carey & R J Sundberg, Advanced Organic Chemistry, Part-A and B (Plenum, US)
2. I L Finar & A L Finar, Organic Chemistry, Vol. 2 (Addison- Wesley)
3. I L Finar, Organic Chemistry, Vol. 1 (Longman)
4. J March, Advanced Organic Chemistry (John Wiley & Sons)

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 stereochemistry of organic compounds.	PO1
CO2	Analyze different configuration for the nomenclature of organic compounds.	PO1
CO3	Understand regarding geometrical isomerism.	PO1
CO4	Understand variety of conformational isomer	PO1
CO5	Learn about the reaction mechanism.	PO2
CO6	Understand the role of reaction intermediates.	PO2

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BS CH 703	**STEREOCHEMISTRY, REACTION MECHANISMS AND INTERMEDIATES**	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2	**3**														
CO3	**3**														
CO4	**3**														
CO5		**3**													
CO6		**3**													

BSCH705	Thermodynamics and Electrochemistry	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Physical Chemistry (Graduation level)				
Co-requisites	--				

Course Objectives

1. To have a basic understanding of thermodynamic parameters such as the internal energy, enthalpy, entropy, and Gibbs free energy.
2. To learn the Laws of Thermodynamics and apply them to determine the spontaneity of a reaction and derive.
3. To develop an analytic ability to solve problems relevant to statistical thermodynamics.
4. To understand the electrochemistry of solutions.

Course Outcomes

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

CO1. Explain fundamental thermodynamic properties.

CO2. Derive Maxwell relations and other relevant thermodynamic equations.

CO3. Understand and apply the concept of chemical potential.

CO4. Account for the physical interpretation of partition functions and be able to calculate thermodynamic properties of model systems using Maxwell-Boltzmann distribution.

CO5. Derive Debye-Huckel theory of activity coefficients.

CO6. Demonstrate a better understanding on the fundamental principles of electrochemistry as well as their contemporary applications.

Catalog Description

In this course students will be exposed to the concept and theory based on the thermodynamic properties of materials. They will also study the thermodynamic functions and the relation with electrochemistry.

Course Content

Unit I: 18 Lectures

Introduction, revision of basic concepts: Ideal and non-ideal solutions, Rault's law. Duhem-Margules equation and its applications to vapor pressure curves (Binary liquid mixture). Extensive and intensive properties. Gibbs-Duhem equation and its applications to study of partial molar quantities. Henry's law. Thermodynamics of nonelectrolyte solutions. Excess and mixing thermodynamic properties. Entropy and third law of thermodynamics. Methods of determining the practical absolute entropies.

Unit II: 12 Lectures

Entropies of phase transition. Maxwell relations, thermodynamic equation of state, chemical potential, variation of chemical potential with temperature & pressure. Equilibrium constants and general conditions of equilibrium in terms of thermodynamic potentials.

Statistical Thermodynamics: Weights and configurations, the most probable configuration, thermodynamic probability and entropy: Boltzmann – Planck equation. Ensembles, ensemble average and time average of property. Maxwell-Boltzmann (MB) distribution law and its application to viscosity and diffusion of gases. Partition function and its significance.

Unit III: 18 Lectures

Rotational, translational, vibrational and electronic partition functions. Use of spectroscopic data for evaluation of various partition functions. Relationship between partition function and thermodynamic properties. Sackur tetrode equation. Calculation of equilibrium constant using Partition function.

Unit IV: 12 Lectures

Electrochemistry: Electrochemistry of solutions. Activity coefficients and ion-ion interactions. Physical significance of activity coefficient. Mean activity coefficient of an electrolyte and its determination. Derivation of Debye-Huckel theory of activity coefficients (both point ion size and finite ion size models)

Text Books

1. S Glasstone, An Introduction to Electrochemistry (Maurice Press)
2. J O M Bockris and A K N Reddy, Modern Electrochemistry Vol. I & II (Springer US)
3. H K Moudgil, Text book of Physical Chemistry (Prentice-Hall)

Reference Books/Materials

1. R C Srivastava, S K Saha and A K Jain, Thermodynamics A Core Course (Prentice-Hall of India)
2. L K Nash, Elements of statistical thermodynamics (Addison Wesley)
3. S Glasstone, Thermodynamics for Chemists (D Van Nostrand)

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	Explain fundamental thermodynamic properties.	**PO1**
CO2	Derive Maxwell relations and other relevant thermodynamic equations.	**PO3**
CO3	Understand and apply the concept of chemical potential.	**PO1**
CO4	Account for the physical interpretation of partition functions and be able to calculate thermodynamic properties of model systems using Maxwell-Boltzmann distribution.	**PO2**
CO5	Derive Debye-Huckel theory of activity coefficients.	**PO4**
CO6	Demonstrate a better understanding on the fundamental principles of electrochemistry as well as their contemporary applications.	**PO10**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 705	Thermodynamics and Electrochemistry	3	2	1	2			1	1	1	2	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2			**3**												
CO3	**3**														
CO4		**3**													
CO5				**3**											
CO6										**3**					

BSMA715	MATHEMATICS	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	**60**				
Pre-requisites/Exposure	Basics of Mathematics				
Co-requisites	--				

Course Objectives

1. Provide the brief knowledge of Matrix and Determinants.
2. To understand and find the spherical representation of functions and solve vector related problems.
3. Recognize the different type of the function and find the differentiation.
4. Understand the general and special methods of integration and apply to solve different type of differential equations.

Course Outcomes

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

CO1. Applied the matrix and determinants properties to solve different type of problems.

CO2. Recognize the higher order derivate and apply the integral formula to solve different type of the problems.

CO3. Determine and solve the problems related differentiation of any function.

CO4. Recognize the general and special methods of integration and solve integrals related to chemistry.

CO5: Determine the concept of differential equation and solve related problems.

Catalog Description

The Mathematics course introduces fundamental math concepts. The topics include matrices and determinant, vectors, differential and integral calculus and proportions. The focus is on learning the computational procedures and then applying the skills to problem solving in applications. This course will be equally beneficial to various scientific areas including, life science, chemical science, material science and environmental science.

Course Content

Unit I: 15 Lectures

Matrices and Determinants:

Definition of matrix, types of matrices (row, column, null, square, diagonal). Matrix algebra: addition, subtraction, and multiplication by a number, matrix multiplication. Transpose and adjoint of matrix, elementary transformation, representation and applications to solutions of linear equations. Definition of determinant, and its properties, evaluation of determinants. Application to simple chemistry problems. formulae in organic, inorganic and physical chemistry.

Unit II: **15 Lectures**

Cartesian coordinates:

Plane polar coordinates, spherical representation of functions, the complex Plane, polar coordinates in trigonometric functions.

Vectors:

Representation and simple properties of vectors (addition and subtraction) vector addition by method of triangles, resolution of vectors. Scalar product of vector. Concept of normalization, orthogonality and complete set of unit vectors.

Unit III: **15Lectures**

Differential Calculus:

Derivative of a function, Derivatives of sum, differences, product, and quotient of functions, Derivative of polynomial, trigonometric, exponential, logarithmic, inverse trigonometric and implicit functions, Logarithmic Differentiation, Derivatives of functions in parametric forms, Differentiation by substitution. Partial derivatives, the total derivative, maxima and minima theorem, and simple examples related to chemistry.

Unit IV: **15 Lectures**

Integral calculus:

General and special methods of integration, geometric interpretation of integral, evaluation of definite and some standard integrals related to chemistry. The significance of 'exponential' equations. Differential equations: simple differential equations, separable variables, homogeneous equations, exact equations, linear equations, and equations of first and second order. Application to simple chemistry problems.

Textbooks:

1. R Mortimer, Mathematics for Physical Chemistry, (Academic Press)

Reference Books:

1. F Daniel, Mathematics for physical chemistry (McGraw Hill)
2. DM Hirst, Chemical Mathematics (Longman)
3. G Stephemen, Mathematical Methods for Science Students (Prentice Hall)
4. P Yates, Chemical calculations – Mathematics for Chemistry (CRC Press)
5. T R Barrante, Applied Mathematics for Physical Chemistry
6. Differential Calculus by Shanti Narayan (S. Chand & Co.)
7. Integral Calculus by Shanti Narayan (S. Chand & Co.)

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	Applied the matrix and determinants properties to solve different type of problems.	**PO5**
CO2	Recognize the higher order derivate and apply the integral formula to solve different type of the problems.	**PO2**
CO3	Determine and solve the problems related differentiation of any function.	**PO2**
CO4	Recognize the general and special methods of integration and solve integrals related to chemistry.	**PO2**
CO5	Determine the concept of differential equation and solve related problems.	**PO2**

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	`	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA715	Mathematics		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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1					**3**										
CO2		**3**													
CO3		**3**													
CO4		**3**													
CO5		**3**													

BSCH751	Inorganic Chemistry-I Lab	L	T	P	C
Version 1.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of Inorganic Complex preparation				
Co-requisites	--				

Course Objectives

1. To strengthen the students with inorganic complex preparations.
2. To expertise the students in organometallic complex preparation.

Course Outcomes

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

CO1. To enable the students about general of inorganic synthesis

CO2. Gain knowledge about the Inorganic Complex preparation techniques

CO3. To enable the student about some experimental techniques for organometallic compounds

CO4. Acquire experience of handling instruments for organometallic compounds

Catalog Description

This course imparts the basic concepts of inorganic complex preparation which enable them to perform experiment by using a suitable synthetic procedure. This course helps them to get experience of working as a chemist on individual level or in a group to perform scientific experiments. The course also introduces the preparation of complex organometalliccomplexes.

Course Content

Preparations of Inorganic Complex Compounds: 30 Hours

1. Prussian Blue (Potassium Ferric Ferro cyanide)
2. Reineckes salt (Ammonium diammine tetra thio cyanato chromate (III))
3. Potassium tri oxalato ferrate (III) trihrdrate.
4. trans-potassium di aqua bis(oxalato) chromate (III)
5. cis-potassium di aqua bis (oxalato) chromate (III)
6. Sodium hexa nitrito cobaltate (III)
7. tris (acetylacetonato) manganese (III)
8. Bis(acetylacetonato) complexes of Cu(II), Co(II)
9. $[Cr(NH_3)_6]Cl_3$
10. $[Ti(urea)_6]I_3$
11. Organotin complexes

Textbooks

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

Reference Books/Materials

1. W G Palmer, Experimental Inorganic Chemistry (Cambridge: University Press)
2. W R Schoeller and A.R. Powell, The analysis of minerals and ores of the rarer elements (Charles, Griffin and Company Limited)
3. G Pass & H Sutcliffe, Practical Inorganic Chemistry (Chapman Hill)
4. O. P. Pandey, D.N. Bajpai, S.Giri, Practical chemistry, S. Chand & Company Pvt. Ltd.

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

Components	Conduct of Experiment	Lab Record/Quizzes/ Viva-Voce	Attendance	End Term Practical Examination
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	To enable the students about general of inorganic synthesis	PO1
CO2	Students have knowledge about the Inorganic Complex preparation techniques	PO2
CO3	To enable the student about some experimental techniques for organometallic compounds	PO1
CO4	Acquire experience of handling instruments for organometallic compounds	PO4

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH751	**Inorganic Chemistry-I Lab**	3	3	2	3			2		1		3	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2		**3**													
CO3	**3**														
CO4				**3**											

BSCH753	ORGANIC CHEMISTRY-I LAB	L	T	P	C
Version 1.0		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. Understanding of identification of binary mixture of organic compounds.

CO2. Apply reaction mechanism in the synthesis of different organic compounds.

CO3. Understanding of different name reactions.

CO4. Learn about purification of substances.

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

Catalog Description

This course comprise of identification of binary mixtures of organic compounds. This course also provides hands on experience of doing some specialized reactions.

Course Content

List of experiments: 30 Hours

1. Purification of binary mixtures by Thin Layer Chromatography (TLC) and Column chromatography (CC).
2. Single stage organic preparations involving various types of reactions

a) Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol/ P-benzoquinone from hydroquinone
b) Cannizzaro reaction: 4-chlorobenzyldehyde as a substrate.
c) Aldol condensation: Dibenzal acetone from benzaldehyde.
d) Sandmeyer reaction: p- Chlorotoulene from p-toluidine/ o-chlorobenzoic acid from anthranillic acid
e) Preparation of cinnamic acid by perkin's reaction
f) Knoevenagel condensation reaction
g) Coumarin Synthesis
h) Synthesis of p-Nitroaniline and p- bromoaniline(Aromatic electrophilic substitutions)

3. Qualitative Analysis of Binary Mixtures (only two)

(Any suitable Expt. may be added)

Practical Books:

1. B S Furniss, A J Hannaford, P W G Smith and A R Tatchel, Vogels Textbook of Practical Organic Chemistry (ELBS with Longman, Longman Singapore Publishers Pt. Ltd, Singapore.)
2. F G Mann and B C Saunders Dorling, Practical organic chemistry (Kindersley (India) Pvt Ltd., New Delhi)
3. H T Clarke, A Handbook of organic analysis: Qualitative and quantitative (E. Arnold and Co., London)

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

Components	Conduct of Experiment	Lab Record/Quizzes/ Viva-Voce	Attendance	End Term Practical Examination
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	Understanding of identification of binary mixture of organic compounds.	PO1
CO2	Apply reaction mechanism in the synthesis of different organic compounds.	PO5
CO3	Understanding of different name reactions.	PO5
CO4	Learn about purification of substances.	PO1
CO5	Learn about the environment safety at the time of performing experiment.	PO6

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH753	ORGANIC CHEMISTRY –I LAB	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2					**3**										
CO3						**3**									
CO4	**3**														
CO5							**3**								

BSCH755	Physical Chemistry-I Lab	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 learn the theory behind potentiometric titrations.
2. To calculate dissociation constant of weak acids making use of conductance values.
3. To understand the working principle behind thermochemistry experiments.
4. To determine relative strengths of acids in a given mixture.

Course Outcomes

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

CO1: Perform conductometric titrations between acids and bases of different strengths.

CO2: Calculate solubility and solubility product with the help of conductometry as well as potentiometry.

CO3: Carry out potentiometric titrations between several different solutions.

CO4: Calculate heats of dilution and similar processes.

CO5: Determine molar conductance at infinite dilution with the help of Kohlrausch's law.

CO6: Figure out molecular radius of organic compounds.

Catalog Description

This course imparts the basic concepts and protocols of potentiometry, conductometry, thermodynamics and refractometry. It enables students to perform several diverse types of titrations that can be done making use of potential measurements and conductance measurements. The course also includes experimental ways find out heat of several processes, like, dilution, dissolution, and fusion.

Course Content

List of experiments: 30 Hours

1. Potentiometry: Determination of solubility and solubility product of silver halides, determination of binary mixture of weak and strong acid etc.
2. Conductometry: Determination of mixture of acids and relative strength of weak acids.
3. Conductometric titration of a weak acid with strong base.
4. Conductometric titration of a mixture of weak and strong acids
5. To determine equivalent conductance at infinite dilution of strong electrolytes and Weak acid by using Kolharausch Law and dissociation constant for weak acid conductometrically.

6. Refractometry: Determination of molecular radius of molecule of organic compound.
7. Thermochemistry Determination of heats of dilution and integral heat of solutions.
8. Latent heat of Fusion Determination of latent heat of fusion of a given solid.
9. Determine the solubility and solubility product of an insoluble salt, AgX (X=Cl, Br) potentiometrically.
10. Titrate potentiometrically solution of KCL/KBr/KI

Practical Books

1. B Viswanathan and P S Raghavan, Practical Physical Chemistry (Viva books)
2. V D Athawale and Parul Mathur, Experimental Physical Chemistry (New Age International Pvt. Ltd.)
3. A Finlay and J A Kitchener, Practical Physical Chemistry (Longman)

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

Components	Conduct of Experiment	Lab Record/Quizzes/ Viva-Voce	Attendance	End Term Practical Examination
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 conductometric titrations between acids and bases of different strengths.	PO1
CO2	Calculate solubility and solubility product with the help of conductometry as well as potentiometry.	PO3
CO3	Carry out potentiometric titrations between several different solutions.	PO2
CO4	Calculate heats of dilution and similar processes.	PO1
CO5	Determine molar conductance at infinite dilution with the help of Kohlrausch's law.	PO4
CO6	Figure out molecular radius of organic compounds.	PO2

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH755	Physical Chemistry-I Lab	2	2	3	3				2	1	3	2	2	3	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2			**3**												
CO3		**3**													
CO4	**3**														
CO5				**3**											
CO6		**3**													

SEMESTER II

BSCH708	**Boron, silicates and organometallic compounds**	L	T	P	C
Version 2.0		4	0	0	4
Total Contact Hours	**60**				
Pre-requisites/Exposure	Chemical properties of B, Si and organometallic compounds				
Co-requisites	--				

Course Objectives

1. To learn basics chemistry and properties of compounds based on B and Si
2. To learn characteristic properties and bonding in organometallic compounds
3. To study the characteristics features and applications of clay, zeolites
5. To enable the students about metallocycles and dinitrogen complexes

Course Outcomes

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

CO1. Explain and draw structures of boron compounds and carboranes

CO2. Students will get an idea about the silicates and aluminosilicates

CO3. To aware the student about general characteristics of organometallic complexes

CO4. Learn to know the basic knowledge of bonding in organometallic complexes

CO5. Acquire complete knowledge of structure, properties and applications of clays and zeolite

CO6. Acquaintance with the chemistry of metal carbonyls and metallocycles

Catalog Description

Various organometallic compounds are synthesized 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 the structure and bonding in those compounds. In this course students will be able to learn and understand the characteristic properties, structures and bonding in boron and silicon based compounds. This course also helps them to get idea about the applications and research importance of clays and zeolites.

Course Content

Unit I: Chemistry of Boron compounds: **14 Lectures**

Chemistry of inorganic rings, cages and metal cluster compounds, borazines, phosphazenes, polyhedral boranes, higher Boranes, carboranes, metalloboranes and metallocarboranes; Classification, Nomenclature, preparation, structure and bonding.

Unit II: Silicates and aluminosilicates: **16 Lectures**

Classification, structure, properties and applications of naturally occurring silicates and aluminosilicates. Synthesis of pillared clays and zeolites.
Characterization of clays, pillared clays and zeolites from measurement of surface area, surface activity, pores size distribution and interlayer spacing.
Application of clays, pillared clays and zeolites with emphasis of catalysis.

Unit III: Organometallics-I: **14 Lectures**

General Introduction, Structure and bonding, importance of organometallic chemistry, Survey of Organometallic complexes according to ligands. π bonded organometallic compounds including carbonyls, binary carbonyls, mixed metal polynuclear carbonyls; nitrosyls, tertiary phosphines, hydrides, alkene, alkyne, cyclobutadiene, cyclopentadiene, arene compounds and their M. O. diagrams.

Unit IV: Organometallics-II: **16 Lectures**

Synthetic Applications of Organometallic Reagents, Reagents and Applications of Organotransition element reagents (viz. Pd-coupling reactions, Pauson Khand, Rh-cyclopropanation, olefin metathesis, Tebbe's, Ziegler-Natta, McMurry, Wilkinson, Schrock, other reductions, etc.), Organo-Sn, Organo-Ti, Grignard, Organo-Pb, etc., Carbenes.Applications of organometallics in organic synthesis; C-C bond coupling, reactions (Heck, sangoshira, Suzuki); Reduction using transition metal hydrides, asymmetric hydrogenation. Olefin metathesis.

Textbooks

1. Inorganic Chemistry (5th Edition, Oxford University Press, Oxford)
2. D M Adams, Inorganic Solids: An Introduction to Concepts in solid- Wells A.F., Structural state Structural Chemistry (John Wiley and Sons, London).
3. G E Coates, M L H Green & P Powell, Principles of Organometallic chemistry, (Chapman & Hall: UK)

Reference Books/Materials

1. Tristram Chivers, Ian Manners, Inorganic Rings and Polymers of the p-Block Elements : From Fundamentals to Applications (Royal Society of Chemistry)
2. P Braunstein, L A Oro and P R Raithby (editors), Metal Clusters in Chemistry (Wiley-VCH)
3. J D Woollins, Non-Metal Rings, Cages and Clusters (John Wiley & Sons)
4. L V Azaroff, Introduction to solids (Tata McGraw Hill Publishing Co. Ltd. Bombay-New Delhi)
5. G L Miessler and D A Tarr, Inorganic Chemistry (Pearson, Delhi)
6. B Douglas, D H Mc Daniel and J J Alexander, Concepts and Models of Inorganic Chemistry (John Wiley and Sons, New Delhi)
7. D W Breck, Zeolites Molecular Sieves- Structure, Chemistry and Use (John Wiley & Sons, N. Y.)
8. M L H Green, Organometallic compounds (Chapman & Hall: UK)

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	Explain and draw structures of boron compounds and carboranes	PO1
CO2	Students will get an idea about the silicates and aluminosilicates	PO2
CO3	To aware the student about general characteristics of organometallic complexes	PO2
CO4	Learn to know the basic knowledge of bonding in organometallic complexes	PO1
CO5	Acquire complete knowledge of structure, properties and applications of clays and zeolite	PO3
CO6	Acquaintance with the chemistry of metal carbonyls and metallocycles	PO1

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
- BSCH 708	**Boron, silicates and organometallic compounds**	3	3	2					2		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**	**PO 10**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2		**3**													
CO3		**3**													
CO4	**3**														
CO5			**3**												
CO6	**3**														

BSCH704	Spectroscopy of Organic Compounds	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Graduation level Chemistry				
Co-requisites	--				

Course objective: Analysis of the given chemical compound is most important and tedious task in chemistry. In this course the students will be exposed to

1. the principles, instrumentation and applications of infrared spectroscopy which is helpful in identification of functional groups.
2. laws of **s**pectrophotometry and applications of ultraviolet spectrophotometer for analysis of unsaturated organic compounds
3. application of nuclear magnetic and mass spectroscopy for structure and molecular weight determination respectively

Course Outcomes

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

CO1: understand the basic concepts and 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

Spectroscopy is a very powerful tool used for characterization and identification of structure of organic compounds. Good understanding of this spectroscopy will enable students to decipher the structure of organic compounds by simple analysis of IR/NMR and mass spectra. The technique is also beneficial to distinguish geometric isomers, stereoisomers and help in finding purity of compounds.

Course Content

Unit I: UV-VIS and Infrared spectroscopy 15 Hours

Beer – Lambert's Law and molar extinction coefficient; Oscillator strength and intensity of the electronic transition; Frank Condon Principle; Ground and first excited electronic states of diatomic molecules; Relationship of potential energy curves to electronic spectra; Chromophores, auxochromes, blue shift, red shift, hypo and hyperchromic effect; Transitions in organic molecules; Woodward rules for conjugated dienes, unsaturated carbonyl groups and extended conjugation aromatic systems, Quantitative applications.

Introduction to Infrared spectroscopy; Nature of radiation; Energies corresponding to various kinds of radiation; Experimental techniques; Intensities of spectral lines; Selection rules and transition moments; Characteristic vibrational frequencies of different functional groups; Effects of H-bonding and solvent effect on vibrational frequency; Application of IR for structural elucidation.

Unit II: Nuclear magnetic resonance spectroscopy-I **15 Hours**

PMR: Natural abundance of ^{13}C, ^{19}F and ^{31}P nuclei; The spinning nucleus; Effect of external magnetic field; Precessional motion and frequency; Energy transitions; Chemical shift and its measurements; Factors influencing chemical shift; Anisotropic effect; Spin-spin coupling: Splitting theory, one, two and three bond coupling, virtual, long range and allylic coupling; Coupling constant; Factors affecting the coupling constant; Chemical and magnetic equivalence; First and second order spectra: A_2, AB, AX, AB_2, AX_2, A_2B_2 and A_2X_2 spin systems; Simplification of complex spectra (solvent effect, field effect, double resonance and lanthanide shift reagents); Continuous Wave and Fourier Transform NMR; Relaxation processes; T1 and T2 measurements; Applications of PMR in structural elucidation of simple and complex compounds.

UNIT III: Nuclear magnetic resonance spectroscopy-II **16 Hours**

^{13}C-NMR: Resolution and multiplicity of ^{13}C NMR; ^{1}H-decoupling, Noise decoupling; Broad band decoupling; Deuterium, fluorine and phosphorus coupling; origin of nuclear overhauser effect; Off-resonance, proton decoupling; Structural applications of ^{13}C-NMR.; Pulse sequences, pulse widths, spins and magnetization vectors; Distortionless Enhancement by Polarization Transfer (DEPT) ; Insensitive nuclei enhanced by polarization transfer (INEPT) Introduction to 2D-NMR: Correlation spectroscopy (COSY) and Nuclear overhauser effect spectroscopy (NOESY) spectra.

Unit IV: Mass spectra **14 Hours**

Introduction, methods of ionization EI & CI; Brief description of LD, FAB, SIMS, FD etc.; Ion analysis methods (in brief); Isotope abundance; Metastable ions; General rules predicting the fragmentation patterns; Nitrogen rule; Determination of molecular ion peak; Fragmentation patterns for aliphatic compounds, amines, aldehydes, Ketons, esters, amides, nitriles, carboxylic acids, ethers, aromatic compounds etc.

Textbooks:

1. Y R Sharma, Elementary Organic Spectroscopy (S. Chand)
2. W Kemp, Organic Spectroscopy (McMillan Press Ltd, London)

Reference Books:

1. C N Banwell and E M McCash, Fundamentals of Molecular Spectroscopy (Tata McGraw- Hill, New Delhi)
2. R M Silverstein, G C Basseler and T C Morill Spectroscopic Identification of Organic Compounds (John Wiley and sons, Inc. New York)

3. J R Dyer, Applications of Absorption Spectroscopy of Organic Compounds (Prentice Hall)

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 concepts and fundamentals of UV-Visible spectroscopy	**PO1**
CO2	learn the principle of instrumentation and applications of IR, ^{1}H NMR and ^{13}C spectroscopy.	**PO1**
CO3	understand the mass fragmentation pattern of organic compounds	**PO1**
CO4	analyze IR, UV, NMR, Mass spectrometry data and elucidate the structure of simple organic molecules based upon that data.	**PO2&PO3**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	**Course Title**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 704	**Spectroscopy of Organic Compounds**	3	1	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2	**3**														
CO3	**3**														
CO4		**3**	**3**												

BSCH706	Quantum Chemistry and Chemical Kinetics	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Physical Chemistry				
Co-requisites	--				

Course Objectives

1. To explain how quantum mechanical systems differ from classical systems.
2. To learn to solve the Schrodinger equation for model systems and atoms.
3. To determine rate law of chemical change based on experimental data.
4. To apply integrated rate equations to solve for the concentration of chemical species during a reaction of different orders.

Course Outcomes

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

CO1: Conceptualise the limitations of classical mechanics. and solution in terms of quantum mechanics for atomic/molecular systems.
CO2: Understand the need for development of quantum mechanics for atomic/molecular systems.
CO3: Develop an understanding of quantum mechanical operators, quantization, probability distribution, uncertainty principle and application of quantization to spectroscopy.
CO4: Understand the concept of rate of change associated with chemical change, recognising that the rate of change and how can it be measured.
CO5: Identify the reaction order for a given chemical change.
CO6: Explain the function and purpose of enzyme catalyst.

Catalog Description

This course imparts the basic concepts of quantum chemistry and chemical kinetics. It enables the students to understand wave functions and principles based on quantum chemistry. They will be exposed to several quantum mechanical operators with special emphasis on linear and angular momentum operators. The course will discuss the rate of chemical reactions and the laws used in chemical kinetics. The students will also learn about the concepts of enzyme catalysis and its mathematical treatment.

Course Content

Unit I: 18 Lectures

Uncertainty principle, postulate of quantum mechanics, properties of wave functions, Schrodinger equation, wave function and its interpretation. Normalization and orthogonality, Eigen functions and Eigen values. Solutions of wave equation for a free particle and particle in a box problem. Transition dipole moment integral and selection rules. Application to electronic spectra of conjugated linear organic molecules.

Unit II: 12 Lectures

Linear and angular momentum, Eigen function and Eigen values of angular momentum operator, Ladder operator, addition of angular momenta. Spin angular momenta, symmetric and antisymmetric wavefunctions, Pauli Exclusion Principle, spectroscopic term symbols.

Unit III: 14 Lectures

The rates of reaction, reaction rate, rate laws & rate constants, the determination of the rate law, first order, second order reactions, half-lives, fractional order reactions. Accounting for rate laws, simple reactions, the temperature dependence of reaction rates, reactions approaching equilibrium, consecutive reactions, the steady state approximations, pre equilibria, unimolecular reactions.

Unit IV: 16 Lectures

The kinetics of complex reactions: chain reaction- explosion, photochemical reactions quantum efficiency, fast reactions-flash photolysis, flow techniques, relaxation methods. Enzyme catalysts: Michaelis-Menten mechanism, limiting rate, Lineweaver Burk and Eadie plots enzyme inhibition, competitive and non-competitive inhibition.

Text Books

1. A K Chandra, Introductory Quantum Chemistry (Tata McGraw-Hill)
2. I N Levine, Quantum Chemistry (Pearson Educ., Inc., New Delhi)
3. Donald A. McQuarrie, Quantum Chemistry (Viva Books, New Delhi)
4. P W Atkins, Physical Chemistry (Oxford University press)
5. A A Frost and R G Pearson, Kinetics and Mechanism (ACS publications)

Reference Books/Materials

1. W Kauzmann Quantum Chemistry (Academic press)
2. S Glasstone, Theoretical Chemistry: An introduction to quantum mechanics, statistical mechanics, and molecular spectra for chemists (D. Van Nostrand Company, Inc.)
3. R K Prasad, Quantum Chemistry (New Age International, New Delhi)
4. K J Laidler, Chemical Kinetics (Pearson Education)
5. G L Agarwal, Basic chemical Kinetics (Tata-McGraw Hill)

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	Conceptualise the limitations of classical mechanics and solution in terms of quantum mechanics for atomic/molecular systems.	**PSO1**
CO2	Understand the need for development of quantum mechanics for atomic/molecular systems.	**PO1**
CO3	Develop an understanding of quantum mechanical operators, quantization, probability distribution, uncertainty principle and application of quantization to spectroscopy.	**PO4**
CO4	Understand the concept of rate of change associated with chemical change, recognising that the rate of change and how can it be measured.	**PO3**
CO5	Identify the reaction order for a given chemical change.	**PO2**
CO6	Explain the function and purpose of enzyme catalyst.	**PO1**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 706	Quantum Chemistry and Chemical Kinetics	3	1	2	1			1	2	1	2	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1											**3**				
CO2	**3**														
CO3				**3**											
CO4			**3**												
CO5		**3**													
CO6	**3**														

BSCS 714	COMPUTER APPLICATIONS IN CHEMISTRY	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	**60**				
Pre-requisites/Exposure	Basics of Computer Fundamentals				
Co-requisites	--				

Course Objectives

1. Basic information regarding computer and computing application of internet
2. Programming in computers and C language for chemist.
3. To develop competences of students in using computers to solve problems related to Chemistry.
4. To introduce IT in a simple language to all undergraduate students, regardless of their specialization.
5. To pursue specialized programs leading to technical and professional careers and certifications in the IT industry.
6. To introduce skills relating to IT basics, computer applications, programming, interactive media, Internet basics, etc.
7. To develop good programming skills and to develop problem solving skills.

Course Outcomes

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

CO1. Identify the basic elements required in a computer system.

CO2. Illustrate the role of the computer for personal and professional uses.

CO3. Apply the basic operations of networking applications.
CO4. Recognize advanced resources for accessing scholarly literature from internet.
CO5. Students should develop fundamental skills such as problem solving and abstract reasoning through computer programming.
CO6. Utilize bibliography management software while typing and downloading citations.
CO7. Operate various software resources with advanced functions and its related programming features.
CO8. Understand the difference between an operating system and an application program, and what each is used for in a computer using programming language.

Catalog Description

Computing and programming is essential to leverage the technical skills of a student. These techniques equip the students with know-how of the latest technologies and reduce considerable time in solving problems. The course of computer applications in chemistry has become essentially the present age of computer technology and information, as the applications of information technology in chemistry can be found in all aspects of our lives.

Course Content

Unit I: **18 Lectures**

Introduction to Computers and Computing

Basic structure and functioning of computers with a PC as an illustrative example. Memory, I/O devices. Secondary storage. Computer language. Number System binary, octal, hexadecimal and their interconversions, memory management. Operating systems with DOS as an example. Introduction to UNIX and WINDOWS, MSOffice, Data Processing, principles of programming. Algorithms and flow-charts.

Unit II: **12 Lectures**

Introduction to Networking

(a) Introduction – Server, client and parts, server and network operating system, network cards, cabling and hubs, maintenance and connecting to internet.

(b) Features and concepts of e-mail technology – Message headers, Address book, Attachment, Filtering and forwarding mails.

(c) Application of Internet for Chemistry with search engines, various types of files like PDF, JPG, RTF and Bitmap. Scanning, OMR, Web camera.

Unit III: **18 Lectures**

Computer Programming in C

Overview of C, Constants, Variables, and Data Types, Operators and Expression, Managing Input and Output Operators, Decision Making and Branching, Single and two dimensional arrays, structure , IF statement, IF....ELSE statement, GO TO statement, Decision Making and Looping, WHILE statement, DO statement and FOR statement, Jumps in loop.

Unit IV: **12 Lectures**

Programming in Chemistry

Development of small computer codes involving simple formulae in chemistry, such as Vander Waals equation, titration, kinetics, radioactive decay. Evaluation of lattice energy and ionic radii from experimental data. Linear simultaneous equations to solve secular equations within the Huckel theory. Elementary structural features such as bond lengths.

Textbooks:

1. Pundir & Bansal, Computer of Chemists (Pragati Prakashan)
2. V Rajaraman and T Radhakrishnan, An Introduction to Digital Design (Prentice Hall)

Reference Books:

3. R Kumari, Computer and their application to chemistry (Springer)
4. R Hunt and J Shelley, Computer and Common Sense (Prentice Hall)
5. A C Norris, Computational Chemistry (Wiley, New York)
6. J P Killngbeck, Microcomputer Quantum Mechanics (Adam Hilger)
7. V Rajaraman, Computer Programming in FORTRAN IV (Prentice Hall)

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	Identify the basic elements required in a computer system.	**PO1**
CO2	Illustrate the role of the computer for personal and professional uses.	**PO1**
CO3	Apply the basic operations of networking applications.	**PO1**
CO4	Recognize advanced resources for accessing scholarly literature from internet.	**PO2**
CO5	Students should develop fundamental skills such as problem solving and abstract reasoning through computer programming.	**PO3**
CO6	Utilize bibliography management software while typing and downloading citations.	**PO2**
CO7	Operate various software resources with advanced functions and its related programming features.	**PO3**
CO8	Understand the difference between an operating system and an application program, and what each is used for in a computer using programming language.	**PO5**

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques		Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCS714	**COMPUTER APPLICATIONS IN CHEMISTRY**	2	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**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**													
CO2	**3**													
CO3	**3**													
CO4		**3**												
CO5			**3**											
CO6		**3**												
CO7			**3**											
CO8					**3**									

BSCH756	Inorganic Chemistry-II Lab	L	T	P	C
Version 1.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Qualitative analysis of lanthanides and metal ions				
Co-requisites	--				

Course Objectives

1. To strengthen the students with semi micro analysis.
2. To expertise the students in qualitative analysis of complex inorganic mixture.

Course Outcomes

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

CO1. Learn Gravimetric Analysis.

CO2. Understand the qualitative analysis of Inorganic Compounds

CO3. Learn the Paper Chromatographic separation technique for inorganic ions.

CO4. Identify different elements (transition, inner transition elements) from the given mixture by semi micro analysis method

Catalog Description

This course imparts the understanding of qualitative analysis of complex inorganic mixture by semi micro analysis which enables them to identify lanthanide and transition metal ion in a given mixture. This course helps them to get experience of selecting suitable test procedure for identification of ion by using gravimetric, volumetric and spectrophotometric techniques. The course also introduces the use of paper chromatography technique.

Course Content

(a) Qualitative Analysis of Inorganic Mixture: 30 Hours

Identification of seven radicals including insoluble residue and rare earth metal ions by semi micro analysis.

(i) Rare elements: Tl, W, Se, Mo, Ti, Zr, Ce, Th, V, U, Li

(ii) Insolubles: $PbSO_4$, $SrSO_4$, Al_2O_3, Cr_2O_3, Fe_2O_3, SnO_2, AgX, TiO_2, ThO_2, $WO_2.xH_2O$

b) Quantitative analysis of tri-component mixture of metal ions using gravimetric, volumetric and spectrophotometric techniques.

(i) Mixed solution of Cu^{2+}, Ni^{2+} and Zn^{2+}

(ii) Mixed solution of Ni^{2+}, Zn^{2+} and Fe^{2+}

Textbooks

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

Reference Books/Materials

5. W G Palmer, Experimental Inorganic Chemistry (Cambridge : University Press)
6. V V Ramanujam, Inorganic Semi-Micro Qualitative Analysis (The National Publishing House, Chennai)
7. J Bassett, R C Denny, G H Jeffery and J Mendham, Vogel's Textbook Of Quantities Analysis, Revised (ELBS)

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

Components	Conduct of Experiment	Lab Record/Quizzes/ Viva-Voce	Attendance	End Term Practical Examination
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 Gravimetric Analysis.	PO2
CO2	Understand the qualitative analysis of Inorganic Compounds	PO1
CO3	Learn the Paper Chromatographic separation technique for inorganic ions.	PO1
CO4	Identify different elements (transition, inner transition elements) from the given mixture by semi micro analysis method	PO4

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH756	Inorganic Chemistry-II Lab	3	3	1	3			2		1		3	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1		**3**													
CO2	**3**														
CO3	**3**														
CO4		**3**													

BSCH754	Organic Chemistry-II Lab	L	T	P	C
Version 1.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Graduation level Chemistry				
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 about methods of estimation of phenol/aniline and reducing sugar.

CO2. Apply reaction mechanism in the synthesis of different organic compounds.

CO3. Understanding of determination of saponification and Iodine value.

CO4. Learn about purification of substances.

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

Catalog Description

In this course, the focus will be on thorough hand on practice to double stage synthesize organic compounds. Student will have exposure of estimation of organic compounds and characterization of oils via saponification value and iodine value.

Course Content

List of experiments: **30 Hours**

1. Estimation of phenol/aniline using bromate-bromide solution.
2. Determine the number of hydroxyl and amino groups in the given sample by the acetylation method.
3. Determination of mol. wt. of the given ketone by using 2, 4-DNP method.
4. Estimation of reducing sugar by Fehling solution method.
5. Determination of the saponification value of the given fat or oil sample.
6. Determination of the iodine number of the given fat or oil sample.
7. Determination of concentration of organic compounds by using UV-VIS spectrophotometer.
8. Preparation of organic compounds (Double stage)

a) benzanilide from benzophenone (rearrangement).
b) p-bromoaniline from acetanilide (bromination and hydrolysis).
c) m-nitroaniline from nitrobenzene (nitration and reduction).
d) 1,2,4-triacetoxy benzene from hydroquinone (oxidation and acylation).
e) p-bromo acetanilide from aniline (acetylation and bromination).

(Any suitable Expt. may be added)

Practical Books:

1. R M Roberts, J C Gilbert, L B Rodewald and A S Wingrove Holt, An Introduction to Modern Experimental Organic Chemistry (Ranehart and Winston Inc. New York)
2. D L Pavia, G M Lampmana and G S Kriz, Introduction to Organic Laboratory Techniques – A Contemporary Approach (W. B Saunders Company, 1976)
3. R Adams, J R Johnson and C F Wilcox, Laboratory Experiments in Organic Chemistry (The Macmillan Limited, London)
4. B S Furniss, A J Hannaford, P W G Smith and A R Tatchell ELBS with Longman, Vogels Textbook of Practical Organic Chemistry (Longman Singapore Publishers Pt Ltd,Singapore)

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

Examination Scheme:

Components	**Conduct of Experiment**	**Lab Record/Quizzes/ Viva-Voce**	**Attendance**	**End Term Practical Examination**
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	Learn about methods of estimation of phenol/aniline and reducing sugar.	**PO1, PO2**
CO2	Apply reaction mechanism in the synthesis of different organic compounds.	**PO1, PO2**
CO3	Understanding of determination of saponification and Iodine value.	**PO1, PSO1**
CO4	Learn about purification of substances	**PO3**
CO5	Learn about the environment safety at the time of performing experiment.	**PO6**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	**Course Title**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 704	**Spectroscopy of Organic Compounds**	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**	**3**													
CO2	**3**	**3**													
CO3	**3**										**3**				
CO4			**3**												
CO5						**3**									

BSCH752	Physical Chemistry-II Lab	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 learn about equilibrium and study it experimentally.
2. To perform time-bound experiments in order to do kinetic studies.
3. To conceptualise the theory behind potentiometric titrations.
4. To understand the phase rule and the basic theory behind phase diagrams.

Course Outcomes

On completion of this course, the students will be able to
CO1. Perform experiments that make use of distribution method.
CO2. Apply the distribution method to study the equilibrium.
CO3. Perform time-bound experiments for kinetic studies of various reactions.
CO4. Understand the concept of pseudo-first order reaction with the example of acid hydrolysis of sucrose.
CO5. Carry out potentiometric titrations between several different solutions.
CO6. Perform experiment to plot the phase diagram for binary systems.

Catalog Description

This course imparts the basic concepts of physical chemistry experiments. It enables the students to perform several experiments based on chemical kinetics. The course helps the students to understand the experimental importance of polarimetry and potentiometry. The course introduces several different kinds of titrations.

Course Content

List of experiments: 30 Hours

1. Polarimetry: Kinetics of inversion of cane sugar in presence of strong acid.
2. Chemical Kinetics: Kinetics of reaction between bromate and iodide.
3. Kinetics of iodination of acetone in presence of strong acid etc.
4. Phase diagram of a binary organic system (Naphthalene and Diphenyl).
5. Potentiometric titration of a strong acid with strong base using quinhydrone electrode
6. Rate constant of acid catalyzed hydrolysis of sucrose by chemical method.
7. Degree of hydrolysis of urea hydrochloride by kinetics method.

8. Equilibrium constant of $KI + I_2 \Leftrightarrow KI_3$ by distribution method.
9. To prepare arsenious sulphide sol and compare the precipitating power of mono-, bi – and trivalent anions.
10. Titrate a moderately strong acid(salicylic/mandelic acid) by the

(i) Salt-line method

(ii) Double alkali method.

1. Titrate
   (i) magnesium sulphate against $BaCl_2$ and its reverse titration
   (ii) HCl versus NH_4OH.

(Any suitable Expt. may be added.)

Practical Books:

1. B Viswanathan and P S Raghavan, Practical Physical Chemistry (Viva books)
2. V D Athawale and Parul Mathur, Experimental Physical Chemistry (New Age International Pvt Ltd.)
3. A Finlay and J A Kitchener, Practical Physical Chemistry (Longman)

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

Components	Conduct of Experiment	Lab Record/Quizzes/ Viva-Voce	Attendance	End Term Practical Examination
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 experiments that make use of distribution method.	**PO2**
CO2	Apply the distribution method to study the equilibrium.	**PO3**
CO3	Perform time-bound experiments for kinetic studies of various reactions.	**PO4**
CO4	Understand the concept of pseudo-first order reaction with the example of acid hydrolysis of sucrose.	**PO1**
CO5	Carry out potentiometric titrations between several different solutions.	**PSO1**
CO6	Perform experiment to plot the phase diagram for binary systems.	**PO2**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 752	Physical Chemistry-II Lab	2	3	3	2			1	2	1	3	3	2	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1		**3**													
CO2			**3**												
CO3				**3**											
CO4	**3**														
CO5											**3**				
CO6		**3**													

BSCS762	COMPUTER APPLICATIONS IN CHEMISTRY LAB	L	T	P	C
Version 1.0		0	0	2	1
Total Contact Hours	**15**				
Pre-requisites/Exposure	Basics of Computer Fundamentals				
Co-requisites	--				

Course Objectives

1. Basic information regarding computer and operating system.
2. Programming in computers and C language for chemist.
3. To develop competences of students in using computers to solve problems related to Chemistry using ChemOffice Ultra.
4. To introduce IT in a simple language to all undergraduate students, regardless of their specialization.
5. To pursue specialized programs leading to technical and professional careers and certifications in the IT industry.
6. To introduce skills relating to IT basics, computer applications, programming, interactive media, Internet basics, etc.
7. To develop good programming skills and to develop problem solving skills.

Course Outcomes

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

CO1. Identify the basic elements required in a computer system.

CO2. Illustrate the role of the computer for personal and professional uses.

CO3. Do practice on software for the representation of molecular structures.
CO4. Recognize advanced resources for accessing scholarly literature from internet.
CO5. Students should develop fundamental skills such as problem solving and abstract reasoning through computer programming.
CO6. Utilize bibliography management software while typing and downloading citations.
CO7. Do practice on software for solving algebraical problems.
CO8. Do practice on software for solving numerical problems.

Catalog Description

The course aims to develope competences of students in using computers to solve problems related to Chemistry. Computing and programming is essential to leverage the technical skills of a student. These techniques equip the students with know-how of the latest technologies and reduce considerable time in solving problems. The course of computer applications in chemistry has become essentially the present age of computer technology and information, as the applications of information technology in chemistry can be found in all aspects of our lives.

Course Content

List of experiments: **15 Hours**

1. Computer Fundamentals (Operating Systems e.g. MSDOS, Windows, LINUX).
2. Introduction and application about the computational chemistry & molecular modeling software.
3. Understanding of the chemical structure and physico-chemical properties using chemistry software "ChemOffice Ultra"
    a) Draw a chemical structure and reactions with the example of organic and inorganic substances along with physical notations such as bonding, enthalpy, entropy, etc.
    b) Concept, application and handling of 2D & 3D structure. Draw the structures of biological active molecules.
4. Understand the concept of stereochemistry and draw the stereo chemical structure by using the example of nucleoside and amino acid.
5. Minimization of the chemical structure with the example of nucleoside.
6. Compute the structural and physico-chemical properties (e.g.; bond length, bond angle, dihedral angle, conformation, partial charge, steric energy, etc.) of the target molecule using Chem Draw Tools.
   (Any suitable Expt. may be added)

Practical Books:

1. Ramesh Kumari, Computers and Their Applications to Chemistry (Narosa publications)
2. R Hunt and J Shelley, Computer and Common Sense (Prentice Hall)

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

Components	Conduct of Experiment	Lab Record/Quizzes/ Viva-Voce	Attendance	End Term Practical Examination
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	Identify the basic elements required in a computer system.	**PO1**
CO2	Illustrate the role of the computer for personal and professional uses.	**PO1**
CO3	Do practice on software for the representation of molecular structures.	**PO5**
CO4	Recognize advanced resources for accessing scholarly literature from internet.	**PO2**
CO5	Students should develop fundamental skills such as problem solving and abstract reasoning through computer programming.	**PO3**
CO6	Utilize bibliography management software while typing and downloading citations.	**PO2**
CO7	Do practice on software for solving algebraical problems.	**PO5**
CO8	Do practice on software for solving numerical problems.	**PO5**

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques		Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCS 762	**COMPUTER APPLICATIONS IN CHEMISTRY LAB**	2	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2	**3**														
CO3					**3**										
CO4			**3**												
CO5		**3**													
CO6		**3**													
CO7					**3**										
CO8					**3**										

SEMESTER III

BSCH807	**Coordination Chemistry and Inorganic Polymer Chemistry**	L	T	P	C
Version 2.0		4	0	0	4
Total Contact Hours	**60**				
Pre-requisites/Exposure	Basics of Coordination Chemistry and Polymers				
Co-requisites	--				

Course Objectives

1. To learn the students about the coordination compounds
2. To learn the students concepts and methods to find out the isomerism in coordination complexes
3. To think across and beyond existing chemistry of coordination complexes
4. To communicate clearly and competently matters of color and magnetic properties of coordination complexes
5. Understand basic aspects of the solution properties of polymers, interactions and the relationship to chemical structure, including phase behaviour and the measurement of molecular weight.

Course Outcomes

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

CO1. Identify the difference between structural and optical isomerism.

CO2. Acquire the techniques to determine the color and magnetic properties of coordination complexes.

CO3. Enables to discuss their concern about the bonding and structure of coordination complexes.

CO4. Acquire complete knowledge about the reaction mechanism and labile and inert complexes.

CO5. Determine the ground state term symbol and charge transfer transition on the basis of electronic configuration.

CO6. Interpret the difference between synthesis mechanisms associated with chain-growth and step-growth polymerization, including advanced mechanisms

Catalog Description

This course imparts the basic knowledge of coordination chemistry including their naming, bonding on the basis of valence bond theory and crystal field theory, structure. This course helps them to get an idea about the stereochemistry of coordination complexes. The course introduces the concepts of magnetic and spectral properties of compounds including their colour and different types of polymerization.

Course Content

Unit I: 16 Lectures

Isomerism and Theories of coordination complexes

Geometrical and optical isomerism in octahedral and square planar complexes – Stereochemistry of complexes, Magnetic properties – Dia, para, ferro and antiferro magnetisms - Curie's law – Spin isomerism. Stability constants of complexes and their determination.

Crystal field theory (CFT), Crystal field splitting in octahedral, tetrahedral and square planar complexes, Crystal field stabilization energy and its applications, Weak and strong fields, Pairing energy, Factors affecting the magnitude of crystal field splitting. Limitations of CFT. Adjusted crystal field theory (ACFT) (also called Ligand Field Theory), Molecular orbital (MO) theory for octahedral, tetrahedral and square planar complexes.

Unit II: 14 Lectures

Reaction Mechanism

Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, A, D and I mechanism for metal complexes, Acid hydrolysis, factors affecting acid hydrolysis, Base Hydrolysis, Anation reactions, Substitution reactions in square planer complexes, Mechanism of the substitution reaction, the trans effect, Redox Reaction, Electron Transfer Reactions: Mechanism of one electron transfer reactions, outer sphere type reactions. Cross reactions and Marcus-Hush theory, Inner sphere types reactions.

Unit III: 14 Lecture

Electronic Spectra and Magnetic Properties

Quantum numbers of multi-electron atoms, Russell-Sanders coupling, L-S coupling and micro states, Ground state terms for d^1 – d^{10} ions, Derivation of terms for p^2, p^3, d^1 and d^2 configurations, Hund's rules in the determination of lowest energy states, Selection rules for electronic transitions, Charge transfer transitions. Splitting of free ion terms in octahedral field, correlation diagram, Orgel diagrams for d^1 to d^9 ions and Tanabe-Sugano diagrams for d^2 and d^3 ions.

Unit IV: 16 Lecture

Inorganic Polymers

Charecterestic properties and Classification;- Types of Inorganic Polymerization (step-growth, chain-growth, ring-opening, Reductive Coupling, Condensation synthesis)- Synthesis, properties and applications of important inorganic polymers: Polyphosphazenes , phosphonitrilic halides. Polysiloxanes (Silicones), polysilanes. Coordinate Polymers.- Condensed Phosphates, Silicates, and sulphur-nitrogen compounds.- Isopoly and Hetropoly acid and Salts : Synthesis and structural principles with reference to those of Mo and W.

Textbooks

1. J E Huheey, E A Keither and R L Keiter, Inorganic Chemistry (Harper Collins College Publisher, New York)
2. Geoffrey A Lawrance, Introduction to Coordination Chemistry (Wiley & Sons)

Reference Books/Materials

1. G L Miessler and D A Tarr, Inorganic Chemistry (Pearson, Prentice Publishers, Delhi)
2. D F Shriver, P W Atkins and C H Langford, Inorganic Chemistry (ELBS, Oxford University Press)
3. B Douglas, D H Mc Daniel and J J Alexander, Concepts and Models of Inorganic Chemistry (John Wiley and Sons, New Delhi)
4. Robert B Jordan, Reaction Mechanisms of Inorganic and Organometallic System, (Oxford University Press)
5. Yves Jean, Molecular Orbitals of Transition Metal Complexes (Oxford University Press)
6. C H Langford & H B Gray, Ligand Substitutin Processes (W. A.Benjamin Inc.)
7. Fred Basolo, Ralph G Pearson, Mechanisms of Inorganic Reactions (Wiely Eastern Ltd.)

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	Identify the difference between structural and optical isomerism.	**PO1**
CO2	Acquire the techniques to determine the color and magnetic properties of coordination complexes.	**PO2**
CO3	Enables to discuss their concern about the bonding and structure of coordination complexes.	**PO9**
CO4	Acquire complete knowledge about the reaction mechanism and labile and inert complexes.	**PO2**
CO5	Determine the ground state term symbol and charge transfer transition on the basis of electronic configuration.	**PO2**
CO6	Interpret the difference between synthesis mechanisms associated with chain-growth and step-growth polymerization, including advanced mechanisms	**PO1**

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH807	Coordination Chemistry and Polymer Chemistry	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO 1	**3**														
CO 2		**3**													
CO 3									**3**						
CO 4		**3**													
CO 5		**3**													
CO 6	**3**														

BSCH803	Heterocyclic, Photochemistry And Pericyclic Chemistry	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	**60**				
Pre-requisites/Exposure	12^{th} level Chemistry				
Co-requisites	--				

Course Objectives

In this course students will learn and understand

1. Fundamental principals involved in photochemistry.
2. Classification and nomenclature of heterocyclic compounds, their synthesis and reactions.
3. Concept of photochemistry as applicable to different organic molecules.
4. Chemistry of pericyclic reactions

Course Outcomes

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

CO1: Understand basic concepts involved in photochemistry.

CO2: Learn classification and nomenclature of heterocyclic compounds,

CO3: Study the synthesis and reactions of heterocyclic compounds.

CO4: Learn the concept of photochemistry of alkenes, aromatic and carbonyl compounds.

CO5: Understand the cycloaddition, electro cyclic and sigma tropic reactions.

Catalog Description

Heterocyclic molecules are organic cyclic molecules containing heteroatoms. They are important from the point of view that most of the medicines are derived from heterocyclic molecules. The course gives an understanding about their properties and methodology of their synthesis. Moreover, understanding of photochemical and pericyclic reactions is provided in this course on the basis of molecular orbital symmetry.

Course Content

Unit I: Heterocycles-I **15 Hours**

Hantzsch-Widman nomenclature for monocyclic, fused and bridged heterocycles; General approaches to heterocyclic synthesis; Aliphatic and aromatic heterocycles; Basicity and aromaticity of heterocycles; Syntheses of aziranes, oxiranes and thiiranes; Ring openings and heteroatom extrusion; Synthesis and reactions of azetidines, oxetanes and thietanes; Strain.

Unit II: Heterocycles-II **15 Hours**

Structural and chemical properties of azoles; Synthesis of pyrazole, isothiazole and isoxazole; Synthesis of imidazoles, thiazoles and oxazoles; Nucleophilic and electrophilic substitutions; Ring cleavages; Benzofused analogues. Synthesis of indole and benzofuran; Nucleophilic, electrophilic and radical substitutions; Addition reactions; Indole rings in biology.

Structure, chemical properties (Nucleophilic and electrophilic substitutions) and synthesis of pyridazines, pyrimidines, pyrazines; Synthesis of benzopyrans, quinolines, isoquinolines, benzofused diazines, acridines, phenothiazines and their substitution reactions; Synthesis and reactions of azepines, oxepines. Chemistry of porphyrins and spiro heterocycles.

Unit III: Photochemistry **15 Hours**

Interaction of electromagnetic radiation with matter; Types of excitations; Fate of excited molecule; Quantum yield; Transfer of excitation energy; Actinometry.

Photochemistry of alkenes and carbonyl compounds: Photooxygenation; Photochemistry of aromatic compounds: Photochemical isomerisation, addition and substitution; Photo-Fries rearrangement of ethers and anilides; Barton reaction; Hoffmann-Loefller-Freytag reaction; Di-π-methane rearrangement; Singlet molecular oxygen reactions; Photo-cleavages.

Unit IV: Pericyclic Reactions **15 Hours**

Molecular orbitals: MOs of acyclic and cyclic polyenes and arenes; Classification of pericyclic reactions; Thermal and photochemical reactions; Woodward-Hoffman rules; Three approaches: Conservation of orbital symmetry and correlation diagram, Frontier molecular orbital approach [FMO] and aromatic (Huckel and Mobius) transition state approach.

Cycloaddition reactions: 4n and 4n+2 π electron systems; Diels-Alder reactions: 1, 3-Dipolar cycloadditions and cheletropic reactions; The ene reactions. Electrocyclic reactions: Conrotatory and disrotatory motions, 4n and 4n+2 π electron systems and other systems; Valence tautomerism.

Sigmatropic rearrangements: H-shifts and alkyl-shifts, supra and antarafacial migrations; Cope and Claisen rearrangements; Degenerate Cope rearrangement; Fluxional tautomerism; Wittig rearrangement; 2, 3-sigmatropic shifts.

Textbooks:

1. T L Gilchrist, Heterocyclic Chemistry (Dorling Kinderslay (India) Pvt. Ltd., New Delhi)
2. C H Depuy and O L Chapman, Molecular Reactions and Photochemistry (Prentice-Hall of India (P) Ltd., New Delhi)

Reference Books:

1. L A Paquette, Principles of Modern Heterocyclic Chemistry (W. A. Benjamin, Inc. New York)
2. I L Finar, Organic Chemistry: Stereochemistry and Chemistry of Natural Products, Vol. II (ELBS with Longman, London)

3. C E Wayne and R P Wayne, Principles and Applications of Photochemistry (Oxford University Press, Oxford)
4. N J Turro, Modern Molecular Photochemistry (University Science Books. California)

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 basic concepts involved in photochemistry.	**PO1**
CO2	Learn classification and nomenclature of heterocyclic compounds	**PO1**
CO3	Study the synthesis and reactions of heterocyclic compounds	**PO1**
CO4	Learn the concept of photochemistry of alkenes, aromatic and carbonyl compounds	**PO1**
CO5	Understand the cycloaddition, electro cyclic and sigma tropic reactions.	**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	PSO3	PSO 4
BSCH803	**Heterocyclic, Photochemistry And Pericyclic Chemistry**	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2	**3**														
CO3	**3**														
CO4	**3**														
CO5	**3**														

BSCH805	Polymers	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Physical Chemistry (Graduation level)				
Co-requisites	--				

Course Objectives

1. To learn the properties of micelles and reverse micelles.
2. To study the reaction mechanisms involved in polymer synthesis and the kinetics of these reactions.
3. To describe different types of polymerisation process, and the significance in each of: initiation, propagation, and termination.
4. To understand copolymerisation and reactivity ratios associated with it.

Course Outcomes

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

CO1. Conceptualise various aspects of micellization.
CO2. Understand the relationships between polymer molecular weight, molecular weight distribution, and the properties of polymeric materials.
CO3. Analyse the thermal and mechanical properties of polymers, and demonstrate an ability to predict how the molecular weight will affect these properties.
CO4. Determine polymer molecular weights and molecular weight distributions from different types of techniques.
CO5. Demonstrate an ability to distinguish different polymerisation reactions and their mechanisms/kinetics
CO6. Understand co-polymerisation reaction mechanism and kinetics, and preparation techniques for block and graft copolymer.

Catalog Description

The topics included in this course will help students to study the classification and properties related to the polymers. They will learn about micelle formation above cmc. They will also study about the thermodynamics associated with the process of micellization. This course also includes detailed study of kinetics and mechanism of the polymerisation process and uses of polymers.

Course Content

Unit I: 18 Lectures

Micelles and Macromolecules: Surface active agents and their classification, micellization, hydrophobic interaction, critical micellar concentration (cmc), factors affecting cmc of surfactants, counter ion binding to micelles, thermodynamics of micellization-phase separation and mass action models, solubilization, micro emulsions, reverse micelles.

Unit II: 12 Lectures

Macromolecules:

Introduction: Classification and nomenclature of polymers, composition and polymerization mechanism. Step Polymerization : Reactivity of functional groups, basis for analysis of polymerization, kinetics of step polymerization, self catalysed polymerization, external catalysis of polymerization, step polymerization other than polyesterification non-equivalence of functional groups in polyfunctional reagents.

Radical chain ploymerization : Overall kinetics of chain polymerization, initiation, thermal decomposition of initiators, types of initiators, kinetics of initiation and polymerization, dependence of polymerization rate on monomer, photochemical initiation, initiation by ionizing radiation, pure thermal initiation, redox initiation.

Unit III: 12 Lectures

Co-polymerization and emulsion polymerization: The composition of addition copolymers, kinetics of chain propagation in co-polymerization, qualitative and quantitative theories of emulsion. Polymerization rate, degree and number of polymer particles in emulsion polymerization.

Unit IV: 1 8 Lectures

Molecular weight average and viscosity average molecular weight, molecular weight determination by osmotic method, light scattering method, sedimentation method, diffusion constant, sedimentation equilibrium, viscosity method. Statistics of Linear polymers Molecular weight, molecular weight distribution, polydispersity index, average and end to end distance, average radius of gyration. Conducting polymers.

Text Books

1. F W Billmayer, Text Book of Polymer Science (Wiley-Interscience, New York)
2. Paul J Flory, Principles of Polymer Chemistry (Cornell University Press)

Reference Books/Materials

1.V. Moroi, Micelles, Theoretical and Applied Aspects (Plenum)

2.V R Gowarikar, N V Vishwanathan and J Sridhar, Introduction to polymer Science (Wiley eastern)

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	Conceptualise various aspects of micellization.	**PO1**
CO2	Understand the relationships between polymer molecular weight, molecular weight distribution, and the properties of polymeric materials.	**PO4**
CO3	Analyse the thermal and mechanical properties of polymers, and demonstrate an ability to predict how the molecular weight will affect these properties.	**PO2**
CO4	Determine polymer molecular weights and molecular weight distributions from different types of techniques	**PO3**
CO5	Demonstrate an ability to distinguish different polymerisation reactions and their mechanisms/kinetics.	**PO1**
CO6	Understand co-polymerisation reaction mechanism and kinetics, and preparation techniques for block and graft copolymer.	**PO3**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 805	Polymers	2	1	2	2			1	2	1	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2				**3**											
CO3		**3**													
CO4			**3**												
CO5	**3**														
CO6			**3**												

BSCH851	Inorganic Chemistry – III Lab	L	T	P	C
Version 1.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Basics of titrations, coordination chemistry and analytic techniques				
Co-requisites	--				

Course Objectives

1. To learn students about determination of metal content present in ore/ minerals by quantitative analysis
2. To learn students about the analytical techniques like colorimetry, conductometry.
3. To differentiate between stepwise and overall stability of coordination complexes and their determination.
4. To give hand on experience of analytical techniques.

Course Outcomes

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

CO1. Learn quantitative analysis of minerals/alloys

CO2. Determination of Stability Constant of Complexes.

CO3. Synthesis of coordination complexes using vacuum technique.

CO4. Learn to determine the content of different elements like Cu, iron from their ore by titration method.

CO5. Apply the knowledge of quantitative analysis for the determination of metals from ores/alloys.

CO6. Understand the principle and working of different instruments like colourimeter, conductometer, spectrophotometer, etc.

Catalog Description

This course imparts the quantitative analysis minerals and alloys for determination of metal content by different methods like by simple titration method, iodometry method and colorimetry. This course introduce the synthesis of coordination complexes and helps them to determine the stability constant of coordination chemistry.

Course Content

List of experiments: **30 Hours**

(a) Quantitative analysis of minerals/alloys

1. Analysis the given brass (50-70% Cu+20-40%Zn+0-6%Sn+0-2%Pb+0-1%Fe) sample for its Cu and Zn contents colorimetrically. Alternatively, Cu by iodometry and Zn by EDTA method.
2. Analysis of the given sample of gun metal (90% Cu+10%Sn) for its Cu content by iodometry.
3. To determine ferrous content in the supplied sample of iron ore/rust/steel volumetrically against standard potassium dichromate solution using potassium ferricyanide as external indicator.
4. Analysis of the given sample of dolomite (equimolar $CaCO_3$+$MgCO_3$) for its volatilec matter, insoluble matter, and its Ca & Mg contents by EDTA method.

(b) Determination of Stability Constant of Complexes

(i) The stepwise and the overall stability constants of Cu (II) Sulpho salicylic Acid Complexs.
(ii) The stepwise and the overall stability constants of Mn (II)-Amino Acid (eg Glycine) Complexs.
(c) Synthesis of coordination complexes using vacuum technique.
(Any suitable Expt. may be added)

Practical Books:

1. A I Vogel, A text book of Quantitative Inorganic Analysis (Prentice Hall)
2. W R Schoeller and A.R. Powell, The analysis of minerals and ores of the rarer elements (Charles, Griffin and Company Limited)
3. V I Posypaiko and N A Vasiua, Analytical Chemistry in Metallurgy (Mir Publishe, Moscow)
4. W G Palmer, Experimental Inorganic Chemistry (Cambridge : University Press)

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

Components	Conduct of Experiment	Lab Record/Quizzes/ Viva-Voce	Attendance	End Term Practical Examination
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 quantitative analysis of minerals/alloys	**PO4**
CO2	Determination of Stability Constant of Complexes.	**PO2**
CO3	Synthesis of coordination complexes using vacuum technique.	**PO6**
CO4	Learn to determine the content of different elements like Cu, iron from their ore by titration method.	**PO3**
CO5	Apply the knowledge of quantitative analysis for the determination of metals from ores/alloys.	**PO4**
CO6	Understand the principle and working of different instruments like colourimeter, conductometer, spectrophotometer, etc.	**PO3**

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 851	Inorganic Chemistry – III Lab		2	3	2		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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2	**3**														
CO3	**3**														
CO4	**3**														

BSCH853	Organic Chemistry-III Lab	L	T	P	C
Version 1.0		0	0	4	2
Total Contact Hours	30				
Pre-requisites/Exposure	Graduation level Chemistry				
Co-requisites	--				

Course Objectives

The primary objective of this course is to acquaint students with methods of synthesis of organic molecules by multi step reactions and their purification techniques.

Course Outcomes

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

CO1: learn methods of extraction of natural products.

CO2: purify natural products by chromatographic methods

CO3: synthesize organic molecules by multistage reactions.

CO4: prepare organic dyes and heterocyclic compounds.

Catalog Description

Synthesis of organic molecules is an important task in chemistry and this course provides an opportunity to students to apply their theoretical knowledge to prepare dyes, heterocyclic and other molecules in laboratory.

Course Content

List of experiments: **30 Hours**

1. Purification of tertiary mixtures of amino acids by paper chromatography.
2. Extraction of natural products: Any one of the following – solasodine, caffeine, nicotine, piperine, rosine, carotenoids.
3. Synthesis of heterocyclic compounds.
4. Synthesis of dyes
5. Multistep Organic Synthesis:
   a) Synthesis of 2-chloro-4-bromoaniline from aniline (Bromination and chlorination)
   b) Synthesis of methyl orange from aniline (Aromatic electrophilic substitution and diazocoupling).
   c) Synthesis of benzpinacol and its pinacolone rearrangement.
   d) Synthesis of o-chlorobenzoic acid from phthalimide (Hofmann bromamide and Sandmeyer's reaction).
   e) Synthesis of acridone from o-chlorobenzoic acid. (Hofmann bromamide andSandmeyer's reaction).
   f) Synthesis of 2,4-dinitrophenyl hydrazine from chloro benzene. (Electrophilic and nucleophilic substitution reactions on aromatic ring).
   g) Synthesis of triphenylcarbinol from bromobenzene. (Grignard reaction)

(Any suitable Expt. may be added.)

Practical Books:

1. R M Roberts, J C Gilbert, L B Rodewald and A S Wingrove Holt, An Introduction to Modern Experimental Organic Chemistry (Ranehart and Winston Inc. New York)
2. D L Pavia, G M Lampmana and G. S. Kriz, Introduction to Organic Laboratory Techniques – A Contemporary Approach (W. B. Saunders Company, 1976)
3. R Adams, J R Johnson and C F Wilcox, Laboratory Experiments in Organic Chemistry (The Macmillan Limited, London)
4. B S furniss, A J Hannaford, P W G Smith and A R Tatchell ELBS with Longman, Vogels Textbook of Practical Organic Chemistry (Longman Singapore Publishers Pvt. Ltd, Singapore)
5. J R Mohrig, C N Hammonad, P F Schatz and T C Morrill, Modern Projects and Experiments in Organic Chemistry (W.H. Freeman and Company, New York)

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

Examination Scheme:

Components	**Conduct of Experiment**	**Lab Record/Quizzes/ Viva-Voce**	**Attendance**	**End Term Practical Examination**
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	learn methods of extraction of natural products.	**PO1**
CO2	purify natural products by chromatographic methods	**PO1**
CO3	synthesize organic molecules by multistage reactions.	**PO1**
CO4	prepare organic dyes and heterocyclic compounds.	**PO1**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	**Course Title**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 853	**Organic Chemistry-III Lab**	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2	**3**														
CO3	**3**														
CO4	**3**														

BSCH855	Physical Chemistry-III Lab	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 learn the theory behind potentiometric titrations.
2. To calculate dissociation constant of weak acids making use of absorbance values.
3. To perform time-bound experiments in order to do kinetic studies.
4. To learn the necessary calculations to get the viscosity value from the time of flow.

Course Outcomes

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

CO1: Learn to use Ostwald's viscometer.
CO2: Use colorimeter to record absorbance values at different wavelengths.
CO3: Apply the distribution method to study the distribution of any solute between two solvents.
CO4: Learn and plot Freundlich and Langmuir adsorption isotherms for the adsorbent activated charcoal.
CO5: Understand the concept of critical solution temperature and find it out experimentally
CO6: Operate and record spectra on a UV/visible spectrophotometer.

Catalog Description

This course imparts the basic concepts and protocols of experiments based on viscometry, potentiometry, colorimetry, and spectrophotometry. It enables them to perform adsorption studies and plot the respective isotherm, Freundlich, as well as, Langmuir. It also discusses about physical parameters, like distribution coefficient and critical solution temperature.

Course Content

List of experiments: **30 Hours**

1. Determine the molecular weight of a given macromolecule (PVP) by the viscosity method.
2. Determine the dissociation constant of an indicator colourimetrically.
3. Determine the stability constant of the lead oxalate complex by polarographic method.
4. Titrate potentiometrically a solution of ferrous ions against $KMnO_4/K_2Cr_2O_7$. Carry out the titration in the reverse order.
5. Determination of partition coefficient of iodine between carbon tetrachloride and water.
6. Determination of rate control and order of reaction of hydrolysis of an ester (Methyl acetate) catalyzed by an acid (dilute HCl).
7. To determine the adsorption of aqueous acetic acid by activated charcoal and to study the adsorption isotherm.
8. Determine the dissociation constant of an indicator spectrophotometrically.
9. Record the UV spectrum of a given compound (acetone) in cyclohexane.
   (i) Plot transmittance versus wavelength.
   (ii) Plot absorbance versus wavelength.
10. To determine the adsorption of aqueous acetic acid by activated charcoal and to study the adsorption isotherm.
11. To determine the CST of phenol – water system.

Practical Books

1. B Viswanathan and P S Raghavan, Practical Physical Chemistry (Viva books)
2. V D Athawale and Parul Mathur, Experimental Physical Chemistry (New Age International Pvt Ltd.)
3. A Finlay and J A Kitchener, Practical Physical Chemistry (Longman)

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

Components	Conduct of Experiment	Lab Record/Quizzes/ Viva-Voce	Attendance	End Term Practical Examination
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 Ostwald's viscometer	**PO3**
CO2	Use colorimeter to record absorbance values at different wavelengths.	**PO1**
CO3	Apply the distribution method to study the distribution of any solute between two solvents.	**PO2**
CO4	Learn and plot Freundlich and Langmuir adsorption isotherms for the adsorbent activated charcoal.	**PO4**
CO5	Understand the concept of critical solution temperature and find it out experimentally	**PO3**
CO6	Operate and record spectra on a UV/visible spectrophotometer.	**PO3**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH855	Physical Chemistry-III Lab	2	3	3	3			1	2	1		2	2	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1			**3**												
CO2	**3**														
CO3		**3**													
CO4				**3**											
CO5			**3**												
CO6			**3**												

BSCH802	Chemistry of Materials	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of solid state and inorganic materials				
Co-requisites	--				

Course Objectives

1. To learn the students about solid state and defects of crystals
2. To learn the students about synthesis methods like sol-gel, precipitation techniques, high temperature and high pressure synthesis.
3. Acquire the knowledge of magnetic and electronic properties of inorganic materials.
4. Understand about the analytic techniques like electron microscopy, atomic force microscopy.

Course Outcomes

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

CO1. Explain the significance of various types of defects in crystals.
CO2. Acquire the knowledge of various analytic techniques to determine the size, shape, crystallinity of nanomaterials.
CO3. Enables to discuss their concern about the electronic and magnetic properties of conductors, semiconductors.
CO4. Know about different synthesis methods of various inorganic materials.
CO5. Acquire complete knowledge about the optical fibers and their advantages over conducting fibers.
CO6. Interpret the properties and applications of nanomaterials over bulk materials.

Catalog Description

This course helps the students to interpret difference between nanomaterials and bulk materials and why nanomaterials are preferred over bulk materials. This course helps them to get an idea about the electronic and magnetic properties of inorganic materials with their applications.

Course Content

UNIT I: 18 Lectures

Introduction to the solid state, metallic bond, Band theory (Zone model, Brillouin Zones, Limitations of the Zone model); Defects in solids, Perfect & imperfect crystals, point defects, Line defect and plane defect (definition & explanation of meaning) order & disorder phenomena, Determination of defect, Nonstoichiometric defect (structural and thermodynamic aspects) incorporation of stoichiometric excess of defects, thermodynamics of Nonstoichiometric phases.

Unit II: **12 Lectures**

Synthesis of Inorganic materials:

Synthesis of solidstate materials using different techniques ceramic techniques, co precipitation techniques, sol gel techniques, precursor techniques, high temperature & high pressure synthesis.

Ionic Conductors-

Types of ionic conductors, mechanism of ionic conduction, interstitial jumps, vacancy mechanism, diffusion, super ionic conductors, phase transition & mechanism of conduction in super ionic conductors, examples and applications of ionic conductors.

Unit III: **16 Lectures**

Electronic properties of materials:

a) Organic semiconductors, examples, properties and application

b) Superconductivity, superconductivity in metals, alloys and ceramics materials (mixed oxides) BCS theory, Meissner effect, type I & II superconductors, application of Fullerenes as superconductors.

c) Dielectric polarization: piezoelectricity and Ferro electricity.

d) Lasers and Masers actions, laser production and application.

Magnetic properties of Materials-

Introduction, Magnetization, Electron spin and magnetic moment, Theory of diamagnetism, Langevin theory & paramagnetic susceptibility of solids, ferromagnetism, Domain theory. Hysteresis in magnetism, ferrimagnetisms (ferries) Applications of magnetic materials.

UNIT-IV: **14 Lectures**

Advanced Inorganic Materials:

Solid state Lasers (Ruby, YAG and tunable lasers): Inorganic phosphor materials, Synthesis and advantages of optical fibres over conducting fibres, Diffusion in solids, catalysis and zone refining of metals.

Preparation of nanomaterials and their characteristic differences over bulk materials, Principles of electron microscopy, Dynamic light scattering, Atomic force Microscopy and characterization of nanomaterials.

Textbooks:

1. 1. Wilcox, Preparation and Properties of Solid State Materials: Vol I & II (Dekker)
2. H V K Keer, Principles of the Solid State Chemistry (Wiley Eastern)

Reference Books:

1. Paul Hagenmuller, Preparative Methods in Solis State Chemistry (Elsevier)
2. Lohn Wulff, The Structure and Properties of Materials Vol. IV, Electronic Properties (Wily Eastern)
3. N N Greenwood, Ionic Crystals, Lattice Defects and Nonstiochiometry (Butterworth's)
4. LV Azoroof and J J Brophy, Electronic Processes in Materials (MacGraw Hills)
5. T J Rey et al, The Defect Solid State (Interscience)
6. E A Kroger, Chemistry of Imprefect Crystals (Holland)

7. A R West, Solid state chemistry and its applications (John Wiley & Sons)
8. N Hannay, Treatise on solid state chemistry (Plenum)
9. G Timp Ed., Nanotechnology (Springer-Verlag: N. Y.)

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	Explain the significance of various types of defects in crystals.	PO1
CO2	Acquire the knowledge of various analytic techniques to determine the size, shape, crystallinity of nanomaterials.	PO2
CO3	Enables to discuss their concern about the electronic and magnetic properties of conductors, semiconductors.	PO2
CO4	Know about different synthesis methods of various inorganic materials.	PO6
CO5	Acquire complete knowledge about the optical fibers and their advantages over conducting fibers.	PO3
CO6	Interpret the properties and applications of nanomaterials over bulk materials.	PO6

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	`	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 802	Chemistry of Materials	3	2	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2		**3**													
CO3		**3**													
CO4						**3**									
CO5			**3**												
CO6						**3**									

BSCH804	Advanced Organic Synthesis	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Graduation level Chemistry				
Co-requisites	--				

Course objective: This course provides the students

1. information regarding disconnection approach of organic synthesis.
2. oxidation- reduction reagents and reactions.

Course Outcomes

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

CO1: understand disconnection approach of organic synthesis.

CO2: study oxidation-reduction reagents and reactions.

CO3: get the knowledge about catalytic hydrogenation.

CO4: understand the two level–three level organic synthesis.

Catalog Description

Organic synthesis, the art and science of constructing substances, natural or designed, whose primary element is carbon. 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. A multi-step synthesis of any organic compound requires the chemist to accomplish three related tasks. One approach to organic synthesis is retrosynthetic analysis. With this approach a chemist will start with the structure of their target molecule and progressively cut bonds to create simpler molecules. Reversing this process gives a synthetic route to the target molecule from simpler starting materials. This "disconnection" approach to synthesis is now a fundamental part of every organic synthesis course. It is very important to learn the role of stereospecificity and selectivity in the synthesis process, role of reagents and catalyst for maximum yield. Oxidation and reduction processes will also be discussed.

Course Content

UNIT I: Disconnection Approach-I **15 Hours**

An introduction of synthons and synthetic equivalents, general principles of the disconnection approach, functional group interconversions, the importance of order of events in organic synthesis, one group C-X and two group C-X disconnections, one group C-C disconnection, chemoselectivity, regioselectivity, regiospecificity, stereoselectivity and stereospecificity.

UNIT II: Disconnection Approach-II **15 Hours**

Reversal of polarity, amine synthesis, Synthesis of alkenes -use of Wittig reagents, use of acetylene and aliphatic nitro compounds in organic synthesis, synthesis of three membered rings, photochemistry in organic synthesis-synthesis of four membered rings , uses of ketones in organic synthesis, synthesis of five and six membered rings.

UNIT III: Disconnection Approach-III **15 Hours**

Principle of protection of alcoholic, amino, carbonyl and carboxylic groups, Two group C-C disconnect ion- Diels Alder reactions, 1,3-difunctionalized compounds and alpha, beta-unsaturated carbonyl compounds, control in carbonyl condensations, 1,5 –di functionalized compounds- Michael addition, and Robinson Annelation. Disconnection approach towards the synthesis of Juvabione and their relative merits and demerits.

Total synthesis of the following compounds using disconnection approaches: Vitamin B_{12}, Prostaglandin E_2, F_{2a}, Beta-ecodysone, Menthol, Taxol and Gandriol.

UNIT IV: Oxidation and Reduction **15 Hours**

Oxidation Methods (metal, nonmetal based and organic oxidation methods) CrO_3 (Jones reagent), PDC, PCC, , $KMnO_4$, MnO_2, $NalO_4$, HIO_4 $Pb(OAc)_4$ OsO_4 , RuO_4, mCPBA, Sharpless epoxidation , H_2O_2-NaOH, ozonolysis, Oxidation involving alkoxysulphonium salts, Swern oxidation, SeO_2, Oppenauer oxidation, palladium catalyzed oxidation, Baeyer-Villiger oxidation, Woodward Prevost reaction, Dess-Martin oxidation, IBX oxidation.

Reduction Methods (hydrogenations, complex metal hydride reductions, dissolving metal reductions, other metal & nonmetal based reductions, organic reagents based reduction methods)

Catalytic hydrogenation, Pd/C, PtO_2, H_2/catalyst, (stereochemistry and mechanism),Wilkinson's catalyst, Boranes and Hydroboration reactions, $NaBH_4$,$NaCNBH_3$, $Na(OAc)_3BH$, LAH, DIBAL, superhydrides, R_3SiH, Bu_3SnH, , MVP, NH_2NH_2, MVP reduction, etc. reductions of conjugated systems, Birch reduction, reductive fission of alcohols, Pinacol coupling, McMurry coupling, Deoxygenation of alcohols and carbonyl compounds such as Shapiro reaction.

Textbooks:

1. S Warren, Organic Synthesis: The Disconnection Approach (John Wiley & Sons)
2. J March, Advanced organic chemistry 4th Edn. (John Wiley)

Reference Books:

1. R E Ireland, Organic synthesis (Prentice-hall India, New Delhi)
2. A Jacob, Understanding organic reaction mechanisms (Cambridge Univ Press)
3. A Streitweiser, Jr and C H Heathcock, Introduction to organic chemistry (Macmillan, 1985) R A Y Jones, Physical and mechanistic organic chemistry (Cambridge Univ Press)
4. H O House and W A Benjamin, Modern synthetic reactions (California Press)

5. W Carruthurs, Some modern methods of organic synthesis (Cambridge Univ. Press, London)
6. B S Thyagarajan, Mechanisms of molecular migration, Vols I & II (Pergamon Press, Oxford, 1979)
7. D Barton and W D Wallis, Comprehensive organic chemistry (Pergamon Press, Oxford)
8. I L Finar, Organic chemistry Vol. II (Longman)
9. V K Ahluwalia and R. K. Prashar, Organic reaction Mechanisms (Narosa, New Delhi)
10. W Carruther, Modern methods of organic synthesis (Cambridge University Press)
11. F A Carey and R J Sundberg. Part B – Adv. Organic Chemistry (Kluwer Academic pub.)

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 disconnection approach of organic synthesis.	**PO1&PO2**
CO2	study oxidation-reduction reagents and reactions.	**PO1**
CO3	get the knowledge about catalytic hydrogenation	**PO1**
CO4	understand the two level–three level organic synthesis.	**PO1&PO2**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	**Course Title**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 804	**Advanced Organic Synthesis**	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**	**3**													
CO2	**3**														
CO3	**3**														
CO4	**3**	**3**													

BSCH806	Biophysical Chemistry	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Physical Chemistry and Biology				
Co-requisites	--				

Course Objectives

1. To be able to understand the structure and chemistry of various biomolecules.
2. To understand the various kinds of interactions taking place in the biological system.
3. To decipher the folding of proteins from a thermodynamic point of view.
4. To learn about various methods of separation used for biomolecules.

Course Outcomes

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

CO1. Account for the different interactions that are important for the formation of structures in biological systems and for how thermodynamic parameters can be measured.
CO2. Apply the laws of thermodynamics to the folding of three-dimensional structures of biological macromolecules.
CO3. Appreciate the phenomena of diffusion and sedimentation as applied in the techniques of electrophoresis and analytical ultracentrifugation.
CO4. Have insight into the analysis of ligand binding to protein and its kinetics.
CO5. Display an expertise in the analysis of fluorescence, CD and calorimetric techniques.
CO6. Understand the structure and chemistry of DNA.

Catalog Description

This course imparts the basic concepts of biophysical chemistry. It enables the students to understand the chemistry of several biomolecules. The course of biophysical chemistry helps to understand various interactions involved in the biological system (hydrophilic and hydrophobic). It also discusses the interactions between protein and ligands, and techniques to quantify this binding. The course introduces the basic concepts of separation techniques for biomolecules, like chromatography, sedimentation, electrophoresis, etc.

Course Content

Unit I: 18 Lectures

Introduction to biophysical chemistry: Structure of water, Amino acids, Proteins and Polynucleic acids. The peptide bond. Isoelectric point. Conformations of polypeptide chains, primary, secondary and higher-order structures. Factors affecting analyte structure and stability- pH Effects, Temperature Effects, Effect of solvent Polarity.

Unit II: 12 Lectures

Biological relevance of chemical potential, Hydrophobic and hydrophilic interactions in biological systems. Protein-Solvent interactions-Preferential binding, hydration and exclusion. Protein polymerization models, Protein denaturation models. Factors affecting analyte structure and stability- pH Effects, Temperature Effects, Effect of solvent Polarity.

Unit III: 12 Lectures

Thermodynamics of protein folding/stability by fluorescence, CD and calorimetric techniques. Binding Isotherms, Binding equilibrium, Hill equation. Binding of small ligands by biological macromolecules: Kinetics and energetics of protein-drug, protein-surfactant and DNA-drug interaction by fluorescence, CD and calorimetric methods.

Unit IV: 18 Lectures

Methods for separation of biomolecules: general principals, including Chromatography; sedimentation, Moving boundry sedimentation, zonal sedimentation, Electrophoreses. Chemistry of nucleic acid bases A.G.C.T and U and their synthesis, Structure of DNA. Structure of Starch, Cellulose Glycogen and Chitin.

Text Books

1. L Stryer, Biochemistry(4th edn.) (W. H. Freeman & Co.)
2. A Cooper, Biophysical Chemistry (RSC)
3. U N Dash, Textbook of Biophysical Chemistry (McMillan India)

Reference Books/Materials

1. J P Allen, Biophysical Chemistry (Wiley-Blackwell)
2. R A Alberty, Thermodynamics of Biochemical Reactions (Wiley-Interscience)
3. S Zubay, Biochemistry (Addison-Wesley)
4. A L Lehinger, D L Nelson & M M Cox, Lehninger Principles of Biochemistry 4th Ed. (W. Freeman)

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	Account for the different interactions that are important for the formation of structures in biological systems and for how thermodynamic parameters can be measured.	**PO1**
CO2	Apply the laws of thermodynamics to the folding of three-dimensional structures of biological macromolecules.	**PO2**
CO3	Appreciate the phenomena of diffusion and sedimentation as applied in the techniques of electrophoresis and analytical ultracentrifugation.	**PO4**
CO4	Have insight into the analysis of ligand binding to protein and its kinetics.	**PSO1**
CO5	Display an expertise in the analysis of fluorescence, CD and calorimetric techniques.	**PSO2**
CO6	Understand the structure and chemistry of DNA.	**PO1**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH806	Biophysical Chemistry	2	3	3	3			1	2	1	2	2	2	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2		**3**													
CO3				**3**											
CO4											**3**				
CO5												**3**			
CO6	**3**														

BSCH808	Analytic Techniques	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of electrochemical process				
Co-requisites	--				

Course Objectives

1. To learn the students e to develop the skills to understand the theory and practice of analytical techniques.
2. To provide scientific understanding of analytical techniques and detail interpretation of results.
3. To deliver an in-depth examination of the specific analytical techniques relevant to their research projects.
4. Acquire the include a detailed theoretical background, practical training and a critical understanding of the laboratory-based techniques they will apply during their research projects.

Course Outcomes

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

CO1. Explain the theoretical aspects of key analytical techniques and instruments used in electrochemical process.
CO2. Strategically plan analytical campaigns to apply to different types of samples and research objectives, including selection of the most appropriate technique/instrumentation for the students' research project.
CO3. Undertake the correct sample preparation and characterization prior to analysis by the chosen techniques or instruments.
CO4. Design an analytical work-flow to acquire data and achieve the research objectives of their project.
CO5. Process data from the chosen instruments and demonstrate understanding of the limitations and quality of the data. Justify the approach taken to data processing.
CO6. Write a clear and concise justification and description of the analytical techniques employed, suitable for publication in a scientific journal.

Catalog Description

This course is introduced to bridge the gap between academics, research and industry. This course begins with a review of basic analytical technique and an introduction to general terminologies. This course contains analytical techniques along with their theory, working principal, common instrumentation and possible applications. This course will be equally beneficial to various scientific areas including, life science, chemical science, material science and environmental science.

Course Content

Unit I: **18 Lectures**

Conductometry:

Introduction, principle, technique, electrolytic conductivity, measurement of electrolytic conductivity, conductometric titration, applications.

Unit II: **12 Lectures**

Polarography and Voltammetry:

(a) Introduction, principle, technique, D.M.E., half-wave potential, residual current, migration current, diffusion current, limiting current, applications.

(b) Cyclic voltammetry and anodic stripping voltammetry.

Unit III: **18 Lectures**

Amperometry:

Introduction, principle, types of current, technique, amperometric titrations with DME, amperometric titrations with rotating platinum micro electrode, biampero-metry, applications.

Unit IV: **12 Lectures**

Coulometry:

Introduction, constant current coulometry, controlled potential coulometry (principle and technique), types of coulometer, applications.

Textbooks:

1. H H Willard, Instrumental Methods of Analysis (Wordsworth Publishing Company, Belmont, California, USA)

Reference Books:

1. A I Vogel, A Test book of Quantitative Inorganic Analysis (Rev. by GH Jeffery and others) (The English Language Book Society of Longman)
2. G D Christian and D Gary , Analytical Chemistry (John Willy, New York)
3. S M Khopkar, Basic Concepts of Analytical Chemistry (New Age, International Publisher)
4. D A SKoog, F J Holler and T A Nieman, Principles of Instrumental Analysis (Thomson Asia Pvt. Ltd. Singapore)

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	Explain the theoretical aspects of key analytical techniques and instruments used in electrochemical process.	**PO3**
CO2	Strategically plan analytical campaigns to apply to different types of samples and research objectives, including selection of the most appropriate technique/instrumentation for the students' research project.	**PO2**
CO3	Undertake the correct sample preparation and characterization prior to analysis by the chosen techniques or instruments.	**PO2**
CO4	Design an analytical work-flow to acquire data and achieve the research objectives of their project.	**PO3**
CO5	Process data from the chosen instruments and demonstrate understanding of the limitations and quality of the data. Justify the approach taken to data processing.	**PO3**
CO6	Write a clear and concise justification and description of the analytical techniques employed, suitable for publication in a scientific journal	**PO10**

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 808	Analytical Techniques		2	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1			**3**												
CO2		**3**													
CO3		**3**													
CO4			**3**												
CO5			**3**												
CO6										**3**					

BSCH810	Medicinal Chemistry	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Graduation level Chemistry				
Co-requisites	--				

Course Objectives

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

1. Familiarize with the concept of Prodrug, drug and their classification.
2. build a basic knowledge of the theory of drug activity and staructure activity relationship.
3. knowledge about isolation, structure elucidation and synthesis of some of the important drug

Course Outcomes

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

CO1: Understand the concept of drug and their classification.

CO2: Build a basic knowledge of the theory of drug activity.

CO3: Knowledge about isolation, structure elucidation and synthesis of some of the important drugs.

CO4: understanding about antibiotic, antineoplastic, antipyretics, anticancer and hyponotica and sedative drugs, their mode of action and synthetic methods to production.

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 synthesis of several molecules possessing anti pyretic, sedative, antimalarial and cardiovascular drugs etc. along with their mode of action and metabolism. Theories regarding drug activity will be discussed.

Course Content

UNIT I

Unit I: Introduction **15 Hours**

Concept of drug; Lead compound and lead modification; Prodrugs and soft drugs; Structure-activity relationship (SAR); Quantitative structure-activity relationship (QSAR); Factors affecting bioactivity – resonance, inductive effect, isosterism, bio-isosterism, spatial considerations; Theories of drug activity – occupancy theory, rate theory, induced fit theory. Concept of drug receptors – elementary treatment of drug-receptor interactions; Physico-chemical parameters – lipophilicity, partition coefficient, electronic ionization constants, steric,

Shelton and surface activity parameters and redox potentials; Factors affecting modes of drug administration, absorption, metabolism and elimination; Significance of drug metabolism in medicinal chemistry.

Unit II: Antibiotics **15 Hours**

Cell wall biosynthesis, inhibitors of β-lactam rings, antibiotics inhibiting protein synthesis; Isolation, structure elucidation, synthesis, SAR and mode of action of penicillins; Synthesis of penicillin G, penicillin V, ampicillin, amoxicillin .

Isolation, structure elucidation, synthesis, SAR and mode of action of following antibiotics: streptomycin, tetracyclines and chloroamphanicol.

Antipyretic Analgesics: Classification and mode of action of antipyretic analgesics; Synthesis of paracetamol, chincophan, Novalgin and mefenamic acid.

Antimalarial drug: Nitrogen heterocycles as antimalarial agents, their classification and mode of action and synthesis of chloroquine, primaquine, and pyrimethamine.

Unit III: Drug types – I **15 Hours**

Antineoplastic drugs: Cancer chemotherapy, role of alkylating agents and antimetabolites in the treatment of cancer; Carcinolytic antibiotics and mitotic inhibitors; Synthesis of mechlor-ethamine, melphalan, 5-bromouracil and 6-mercaptopurine; Anticancer action of taxol.

Cardiovascular drug: Classification, synthesis and mode of action of quinidine, verapamil.

Unit IV: Drug types – II **15 Hours**

Hypnotics and sedatives: SAR and mode of action and synthesis of diazepam, oxazepam, barbiturates.

Local anaesthetics: Classification, SAR and mode of action and synthesis of procaine, α-eucaine and β-eucaine, cinchocaine and quinisocaine.

Antiinfective drugs: Mode of action and synthesis of sulphonamides, norfloxacin, daspone, isoniazide.

Textbooks:

1. M E Wolff (eds), Burger Medicinal Chemistry and Drug Discovery, Vol-1 (Wiley Interscience, New York)

Reference Books:

1. L L Brunton, D K Blumenthal, N Dandan, R H Murri, B C Knollmann, Goodman and Gilman: The Pharmacological Basis of Therapeutics (McGraw-Hill, New York)
2. S S Pandeya and J R Dimmock, Introduction to Drug Design (New Age International(P) Ltd, New Delhi)
3. Graham and Patrick, Introduction to Medicinal Chemistry (Oxford University Press, Oxford)
4. T Nogrady and D F Weaver, Medicinal Chemistry (Oxford University Press, Oxford)

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 concept of drug and their classification.	**PO1**
CO2	Build a basic knowledge of the theory of drug activity.	**PO1**
CO3	Knowledge about isolation, structure elucidation and synthesis of some of the important drugs.	**PO1**
CO4	Understanding about antibiotic, antineoplastic, antipyretics, anticancer and hypnotic and sedative drugs, their mode of action and synthetic methods to production.	**PO5**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	**Course Title**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 810	**Medicinal Chemistry**	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2	**3**														
CO3	**3**														
CO4					**3**										

BSCH812	Nuclear Chemistry and Photochemistry	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Physical Chemistry				
Co-requisites	--				

Course Objectives

1. To be able to understand different kinds of radioactive decays.
2. To learn the difference between nuclear fission and fusion.
3. To estimate the age of any sample with the help of carbon dating.
4. To understand electron transfer and energy transfer reactions.

Course Outcomes

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

CO1. Explain nuclear structure, stable and unstable atomic nuclei, nuclear reactions and different modes of radioactive decay.
CO2. Understand different types of nuclear models.
CO3. Conceptualise different types of nuclear reactions and energy associated with it.
CO4. Quote the various types of photochemical reactions.
CO5. Derive Stern-Volmer relationship.
CO6. Understand the importance of solar energy in photochemistry.

Catalog Description

This course imparts the basic concepts of nuclear models and radioactivity. It enables the students to explain nuclear models and nuclear reactions of radioisotopes. The course of nuclear chemistry and photochemistry imparts in depth knowledge about techniques of nuclear chemistry and concepts of inorganic photochemistry.

Course Content

Unit I: 18 Lectures

Nuclear Chemistry I: Nuclear models – Shell model – Liquid drop model - Types of radioactive decay – Decay constant – Half-life period - Alpha decay – Theory of alpha decay - The tunnel effect - Beta decay– Types of beta decay - Electron capture - Dirac's theory - Nuclear deexcitation – Artificial radioactivity. Nuclear reactions: Bathe's notation.

Unit II: **12 Lectures**

Nuclear Reactions: Types of nuclear reactions - Elastic and inelastic scattering – Cross section - Q value – Transuraniens - Photonuclear reaction - Radioactive capture - Evaporation and spallation – Buckshot hypothesis - Thermonuclear reactions – Nuclear fusion - Nuclear fission – Fission fragments - Mass and charge distribution - Fission energy.

Unit III: **18 Lectures**

Nuclear Chemistry II: Breeder reactor – Counting techniques: G.M., Ionization and Proportional counter. Applications of radioisotopes – Esterification – Friedal Craft's reaction – Structural determination of PCl_5 - Solubility of sparingly soluble substance – Isotope dilution analysis – Neutron activation analysis - Radiometric titration – Carbon dating – Thyroiditis - Assessing the volume of blood in a patient - Brain tumor location and bone fracture healing- Optimum use of fertilizers - Control of predatory insects - Prospecting of water and petroleum.

Unit IV: **12 Lectures**

Inorganic Photochemistry: Principle of light absorption – physical and chemical processes – bimolecular reactions- Stern-Volmer relationship- Properties of d-d, π-π and π-n* energy states. Photochemical reactions of metal complexes – substitution- Admson's rules- rearrangement– isomerisation– racemisation– aquation and anation – redox reactions. Ruthenium polypyridyls – excited state properties – electron transfer and energy transfer quenching reactions –importance of solar energy conversion and storage – cleavage of water using $Ru(bpy)_3^{2+}$, Cadmium sulphide colloidal particles and titanium dioxide semiconductor – $[Ru(edta)H_2O]$- Catalysed ammonia production.

Text Books

1. J E Huheey, E A Keither and R L Keiter, Inorganic Chemistry (Harper Collins College Publisher, New York)
2. K K Rohatgi-Mukherjee, Fundamentals of Photochemistry (New Age International Publisher, New Delhi)

Reference Books/Materials

1. H J Arnikar, Essential of Nuclear Chemistry (Wiley- Eastern Ltd., Delhi)
2. G Freindlander, J W Kennedy, E S Macias, and J M Miller, Nuclear and Radiochemistry (John Wiley and Sons, New York)
3. D F Shriver, P W Atkins and C H Langford, Inorganic Chemistry (ELBS, Oxford University Press)

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	Explain nuclear structure, stable and unstable atomic nuclei, nuclear reactions and different modes of radioactive decay.	**PO1**
CO2	Understand different types of nuclear models.	**PSO1**
CO3	Conceptualise different types of nuclear reactions and energy associated with it.	**PO2**
CO4	Quote the various types of photochemical reactions.	**PO1**
CO5	Derive Stern-Volmer relationship.	**PO3**
CO6	Understand the importance of solar energy in photochemistry.	**PO4**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH812	Nuclear Chemistry and Photochemistry	3	2	2	1			1	1	1	1	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2											**3**				
CO3		**3**													
CO4	**3**														
CO5			**3**												
CO6				**3**											

BSCH814	Bio-Inorganic and Supramolecular Chemistry	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Chemistry of toxic elements, human life and plant life				
Co-requisites	--				

Course Objectives

1. To study the use of metals in life processes
2. To learn about various oxygen carrier system in living beings
3. To study the metal poisoning and drug action of inorganic complexes compounds.
4. To understand about the biogeochemistry of trace metals in plants

Course Outcomes

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

CO1. To understand the importance of various metals in life process

CO2. Get an idea about Oxygen Carrier Systems and photosynthesis mechanism

CO3. To learn about metal poisoning due to toxic metals and nitrogen fixation

CO4. To gain knowledge about trace metals and biodegradation of minerals

CO5. Acquire complete knowledge of heavy metals and enzymes

CO6. Determine the metal poisoning and its treatment

Catalog Description

This course imparts the basic knowledge of metal and elements important in life process of human and plants including their role in complexes formation and enzyme activators. This course helps them to know the structure of various enzymes and their mechanism. The course also introduces the toxic metals, their toxicity level and treatment methods with chelate and complexes. This also provides brief idea about the role of trace elements as micronutrients in humans and plants.

Course Content

UNIT I: Metals in Life Processes **15 Lectures**

Na-K-charge carriers & osmotic pressure, relation to sensitivity of nerves and control on muscles, Mg-Ca complexes with nucleic acid, nerve impulse transmission, trigger reaction, Mn, Fe, Co, Cu, Mo, ferridoxins, Zn-super acid catalysis.

UNIT II: **15 Lectures**

Oxygen Carrier Systems-
Structure and mechanism of hemoglobin, vitamin B_{12}, B_{12} co-enzyme myoglobin, synthesis of oxygen carriers.
Photosynthesis- Complexes of prophyries porphyrins ring complexes, redox mechanism.

UNIT III: **16 Lectures**

Nitrogen Fixation-
Nitrogen in biosphere, nitrogen cycle, nitrification role of microorganisms, nitrogen fixation in soils.
Metal poisoning and drug action of Inorganic complexes compounds-
Metal poisoning, treatment by using chelating agent, mercury, lead & cadmium poisoning & treatment. Platinum complexes in treatment of cancer, metal deficiency and use of metal chelates.

UNIT-IV: **14 Lectures**

Trace Metals in Plant Life-
Micronutrients in soil, role of micronutrients in plant life
Biogeochemistry-
Biodegradation of minerals bacteria leaching and its applications.

Textbooks

1. Williams, an Introduction to Bioinorganic Chemistry (C.C. Thomos Spring III)
2. Eichhorn, Inorganic Biochemistry : Vol I, 2 (Elsevier)

Reference Books/Materials

1. Ochiai, Bioinorganic Chemistry (Allyn & Bacon Burton)
2. Wallace, Decade on synthetic chelating agent in Inorganic plant nutrition (Wallace)
3. Zagic, Microbial Biogeochemistry (Academic press)
4. Ahuja, Chemical Analysis of the Environment (Plenum press)

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	To understand the importance of various metals in life process	**PO2**
CO2	Get an idea about Oxygen Carrier Systems and photosynthesis mechanism	**PO1**
CO3	To learn about metal poisoning due to toxic metals and nitrogen fixation	**PO1**
CO4	To gain knowledge about trace metals and biodegradation of minerals	**PO3**
CO5	Acquire complete knowledge of heavy metals and enzymes	**PO2**
CO6	Determine the metal poisoning and its treatment	**PO3**

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 814	Bio-Inorganic and Supramolecular Chemistry	3	3	3	2					2		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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1		**3**													
CO2	**3**														
CO3	**3**														
CO4			**3**												
CO5		**3**													
CO6			**3**												

BSCH816	CHEMISTRY OF LIFE PROCESSES	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of biomolecules and metabolism				
Co-requisites	--				

Course Objectives

1. appreciate chemistry and stereochemistry of carbohydrates.
2. understand Characteristics and mechanism of enzymes.
3. acquire knowledge about structure and functions of amino acid, protein and peptides.

Course Outcomes

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

CO1. Learn about biochemical reactions in various metabolic processes.

CO2. Understand the role of Vitamins and enzymes in life processes.

CO3. Learn regarding metabolism of Carbohydrates and lipids.

CO4. Learn about amino acids, peptides and proteins.

CO5. Application of enzymes in biochemical reaction.

Catalog Description

This course composed of Occurrence, isolation, biological significance (brief idea) and synthesis of the following Vitamins; Structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars; Disaccharides and polysaccharides.; Carbohydrate metabolism; Structures and function of triglycerides, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins; Lipoproteins composition , function and role in arthrosclerosis; Chemical and enzymatic hydrolysis of proteins to peptides; Amino acid sequencing and details of Nucleic acid with An overview of replication of DNA, transcription, translation and genetic code.

Course Content

Unit I: Vitamins and Enzymes 16 Lectures

Occurrence, isolation, biological significance (brief idea) and synthesis of the following vitamins : Vitamin A, E, K, Thiamine, Riboflavin, Pyridoxine, Niacin, Pantothenic acid and ascorbic acid.

Nomenclature; Characteristics (mention of ribozymes); Classification; Active site; Mechanism of enzyme action; Derivation of Michealis Mentis Equation; Stereospecificity of enzymes, coenzymes and cofactors; Enzyme inhibitors; Introduction to biocatalysis: Importance in Green Chemistry and chemical industry.

Unit II: Carbohydrates **16 Lectures**

Conformation of monosaccharides; Structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars; Disaccharides and polysaccharides. Structural polysaccharides: cellulose and chitin; Storage polysaccharides: Starch and glycogen. Structure and biological functions of glucosaminoglycans or mucopolysaccharides; Carbohydrates of glycoprotines and glycolipides; Role of sugars in biological recognition; Carbohydrate metabolism: Kreb's cycle; Glycolysis, glycogenesis and glycogenolysis; Pentose phosphate pathway.

Unit III: Lipids **18 Lectures**

Fatty acids; Essential fatty acids; Structures and function of triglycerides, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins; Lipoproteins composition , function and role in arthrosclerosis; Properties of lipid aggregates : micelles, bilayers, liposomes and their possible biological functions; Biological members : Fluid mosaic model of membrane structure;Lipid metabolism: Oxidation of fatty acids.

Unit IV: **12 Lectures**

Amino acids, peptides and proteins: Chemical and enzymatic hydrolysis of proteins to peptides; Amino acid sequencing; Secondary structure of protein; Forces responsible for holding of secondary structures; helix and sheets; Super secondary structure; Triple helix structure of collagen; Tertiary structure of protein- folding and domain structure; Quaternary structure. Amino acid metabolism: Degradation and biosynthesis of amino acids; Sequence determination: chemical/ enzymatic/ mass spectral, racemization/ detection; Chemistry of oxytocin and tryptophan releasing hormone (TRH).

Nucleic acids: Purine and pyrimidine of nucleic acids; Base pairing via H – bonding; Structure of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA); Double helix model of DNA and forces responsible for holding it; Chemical and enzymatic hydrolysis of nucleic acids; The chemical basis for heredity; An overview of replication of DNA, transcription, translation and genetic code; Chemical synthesis of mono and poly nucleosides.

Textbooks:

1. U. Satyanarayan, Biochemistry (Elsevier India Pvt. Ltd.)

Reference Books:

1. J M Berg, J L Tymoczko and L Stryer, Biochemistry (W.H. Freeman and Co. New York, USA)
2. D L Nelson, M M Cox, and A L Lehninger, Principles of Biochemistry (W.H. Freeman and Co., New York)
3. E E Conn and P K Stumpt, Outlines of Biochemistry (John Wiley)

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 biochemical reactions in various metabolic processes.	**PO3**
CO2	Understand the role of Vitamins and enzymes in life processes.	**PO3**
CO3	Learn regarding metabolism of Carbohydrates and lipids.	**PO3**
CO4	Learn about amino acids, peptides and proteins.	**PO5**
CO5	Application of enzymes in biochemical reaction.	**PO5**

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
- BSCH816	CHEMISTRY OF LIFE PROCESSES	3				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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1			**3**												
CO2			**3**												
CO3			**3**												
CO4					**3**										
CO5					**3**										

BSCH818	Nanochemistry	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Physical Chemistry				
Co-requisites	--				

Course Objectives

1. To be able to understand classification of nanoparticles based on size.
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 applications of nanomaterials in various fields of science.

Course Outcomes

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

CO1. Demonstrate an understanding of the properties of materials with strong dependence on size.

CO2. Understand the classification nanostructured materials.

CO3. Explain different approaches for nanomaterials synthesis and characterization.

CO4. Understand the use of different techniques for the purpose of nanoparticle characteriztion.

CO5. Realise the implications on nanotechnology in research.

CO6. Learn the applications of nanoparticles in the filed of Drug Delivery.

Catalog 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 different applications of nanoparticles in various fields.

Course Content

Unit I: 18 Lectures

Nanoscale building blocks and its applications Zero dimensional nano materials, One dimensional nano materials, Two dimensional nano materials General introduction to nanomaterials and emergence of nanotechnology; Moore's law; synthesis of nanoparticles of gold, rhodium, palladium, platinum and silver; Synthesis of nanoparticle semiconductors, nanowires and nanorods.

Unit II: **12 Lectures**

Techniques of synthesis: electroplating and electro-phoretic deposition, conversion through chemicalr eactions and lithography; Thin films: Chemical vapor deposition and Atomic layer deposition techniques;

Unit III: **18 Lectures**

Carbon fullerenes, Nanotubes, Nanobiotechnology, nanosensors, nanomedicines, etc., Implications of nanotechnology, Experimental methods for preparation of nanomaterials: Chemical and Physical, Characterization techniques for nanomaterials, Size dependent properties of nanoparticles: optical properties, M.P., surface to volume ratio.

Unit IV: **12 Lectures**

Synthesis of Biodegradable and non- biodegradable nanoparticle and their uses in different fields. Future fantasy and nanotechnology. Application of nanotechnology in different fields. Nanotechnology in drug delivery applications.

Text Books

1. G Zhong Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications (Imperial College Press).
2. M Ratner & D Ratner, Nanotechnology: A Gentle Introduction to the Next Big Idea (Pearson Education)

Reference Books/Materials

1. G Schmid, Nanotechnology, Volume 1: Principles and Fundamentals (Wiley Sons).
2. T Pradeep, Nano the Essentials: Understanding Nanoscience and Nanotechnology (Mc Graw Hill.)

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	Demonstrate an understanding of the properties of materials with strong dependence on size.	**PO1**
CO2	Understand the classification nanostructured materials.	**PSO1**
CO3	Explain different approaches for nanomaterials synthesis and characterization.	**PO2**
CO4	Understand the use of different techniques for the purpose of nanoparticle characteriztion.	**PO3**
CO5	Realise the implications on nanotechnology in research.	**PSO4**
CO6	Learn the applications of nanoparticles in the filed of Drug Delivery.	**PO7**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH818	Nanochemistry	3	3	3	3			3	1	1	1	2	1	1	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2											**3**				
CO3		**3**													
CO4			**3**												
CO5														**3**	
CO6							**3**								

BSCH820	Group Theory and Spectroscopy	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of symmetry elements				
Co-requisites	--				

Course Objectives

1. To give the introduction of symmetry and group theory and its role in structure, bonding and reactivity.
2. To provide scientific understanding of spectroscopy and detail interpretation of results.
3. Apply basic concepts to predict the appearance of microwave, vibrational and rotational spectra of organic and inorganic molecules.
4. Explain the general principles and describe the instrumentation of rotational and vibrational spectroscopies.

Course Outcomes

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

CO1. Recognize symmetry in molecules and understand its role in Chemistry.

CO2. Obtain proficiency in the study of symmetries of physical systems.

CO3. Able to describe molecular vibrations with the interaction of matter, and electromagnetic waves.

CO4. Apply molecular spectroscopy in research experiments to determine appropriate experimental methods that are most relevant to a specific problem.

CO5. Develop skills in numeracy and problem solving.

CO6. Acquisition of a theoretical framework which underlies much of spectroscopy.

Catalog Description

The main focus of this course is to provide the students with deeper understanding on spectroscopy. It also emphasis on how molecular symmetry and group theory are usefully related to spectroscopy. In addition, this course also aims to strengthen the knowledge of the students in some fundamental concepts of spectroscopic transition of molecules by combining both spectroscopy and group theory together.

Course Content

Unit I: 16 Lectures

Symmetry elements and symmetry operation, point groups and their classification with examples, sub groups. General methods of assigning point groups to a molecules like water (C_{2v}), ammonia (C_{3v}), phosphorous (D_{3h}) and Xenon tetrafluoride (D_{4h}).

Unit II: **14 Lectures**

Application of group theory to chemical bonding, hybrid orbitals for σ bonding in different geometrics and hybrid orbitals for π bonding, symmetric of molecular orbitals in BF_3, C_2H_4 and B_2H_6.

Unit III: **16 Lectures**

Rotational and vibrational spectroscopy: Introduction, fundamental principle and applications

Unit IV: **14 Lectures**

Raman Spectroscopy- Classical and quantum theories of Raman effect, pure rotational - vibrational and vibrational - rotational Raman spectra, Selection rules, mutual exclusion principle, resonance Raman Spectroscopy.

Textbooks:

1. R Chang, Basic Principles of Spectroscopy (McGraw- Hill, New York, N. Y.)
2. G M Barroe, Introduction to Molecular Spectroscopy (McGraw- Hill)

Reference Books:

1. F A Cotton, Chemical Applications of Group Theory (Wiley Interscience, N. Y.)
2. D M Bishop, Group Theory and Chemistry (Clarenden Press Oxford, U. K.)

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 symmetry in molecules and understand its role in Chemistry.	**PO3**
CO2	Obtain proficiency in the study of symmetries of physical systems.	**PO4**
CO3	Able to describe molecular vibrations with the interaction of matter, and electromagnetic waves.	**PO3**
CO4	Apply molecular spectroscopy in research experiments to determine appropriate experimental methods that are most relevant to a specific problem.	**PO3**
CO5	Develop skills in numeracy and problem solving.	**PO3**
CO6	Acquisition of a theoretical framework which underlies much of spectroscopy.	**PO4**

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	`	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 820	Group theory and spectroscopy			3	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1			**3**												
CO2				**3**											
CO3			**3**												
CO4			**3**												
CO5			**3**												
CO6				**3**											

BSCH822	NATURAL PRODUCT CHEMISTRY	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of reaction mechanism				
Co-requisites	--				

Course Objectives

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

1. build a basic knowledge of the general classification of natural products and their isolation.
2. appreciate the developments regarding terpenoids and vitamins.
3. understand the structure, synthesis and biosynthesis of common alkaloids.
4. learn about isolation and study of important constituents of essential oils and aromatics.

Course Outcomes

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

CO1. Understand regarding Natural products and their importance.

CO2. Analyze the biosynthesis of Natural products.

CO3. Learn about composition, preparation and variety of Terpenoids.

CO4. Learn about composition, preparation and variety of Alkaloids.

CO5. Learn about composition, preparation and variety of Steroids.

CO6. Apply knowledge of essential oils for therapeutic purpose.

Catalog Description

This course imparts the knowledge of natural products availability, properties and biosynthesis. This course provides information regarding variety of Terpenes, Alkaloids and Steroids. The value of essential oils in life is an interesting part of this syllabus. It relates to essential oils isolations and applications.

Course Content

Unit I: Natural products and their biosynthetic pathways 18 Lectures

General classification of natural products, their isolation and characterisation and biosynthesis of common plant products; Biosynthesis pathways for natural products using co-enzymes and enzymes; Synthesis of selected natural products based on genetic classification – fatty acid derivatives and related compounds, general biogenesis and synthesis of cis-jasmone, methyljasmonate, prostaglandins, exaltone and muscone.

Unit II: Terpenoids **12 Lectures**

General biosyntheses of mono- and sesquiterpenes, diterpenes, and higher terpenes, trans-chrysanthemic acid, cyclo-pentato monoterpene lactones; Synthesis of α-vetinone and total synthesis of β-eudesmol; Synthesis of hirsutene, abietic acid, cis juvenile hormone; trans annular cyclisation of caryophyllene, synthesis of caryophyllene and isocaryophyllene; Rearrangements of santonic acid and thujospene; Synthesis and rearrangement of longifolene.

Unit III: Alkaloids and Steroids **12 Lectures**

Structure, synthesis and biosynthesis of common alkaloids: Strychnine, lysergic acid, reserpine, nicotine, morphine, emitine.

Biosynthesis of steroids; Nomenclature of steroids and synthesis of squalene, lanosterol and caretonoids; Synthesis of equlenins; Estrogens and total synthesis of non-aromatic steroids (progesterones); Corticosteroids; Degradation of diosgenin to progesterone and its synthesis.

Unit IV: Essential oils and aromatics: **18 Lectures**

Isolation and study of important constituents of lemon grass oil, citronella oil, cinnamon oil, palmarosa oil, rosemary oil, patchouli oil, peppermint oil, turpentine oil, clove oil, sandalwood oil, lavender oil, rose oil; Essential oils of turmeric and ginger; Oleoresins of pepper, chilly, ginger and turmeric; Use of essential oil in medicine - Aromatherapy.

Textbooks:

1. S V Bhat, B A Nagasampagi, S Minakshi, Natural products: Chemistry and Applications (Alpha Science International Ltd, Oxford)
2. I L Finar, Organic Chemistry, Volume 2: Stereochemistry and the Chemistry Natural Products (Dorling kinderslay (India) Pvt Ltd, New Delhi)

Reference Books:

1. K Nakanashi, Natural Products Chemistry, Vols. I and II (Academic Press, New York and London)
2. E Guenther, The constituent of essential oils (Krieger Publishing Company, New York)

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 regarding Natural products and their importance.	**PO1**
CO2	Analyze the biosynthesis of Natural products.	**PO1 PO2**
CO3	Learn about composition, preparation and variety of Terpenoids.	**PO5**
CO4	Learn about composition, preparation and variety of Alkaloids.	**PO4**
CO5	Learn about composition, preparation and variety of Steroids.	**PO3**
CO6	Apply knowledge of essential oils for therapeutic purpose.	**PO5**

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 808	Analytical Techniques	3	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2	**3**	**3**													
CO3					**3**										
CO4				**3**											
CO5			**3**												
CO6					**3**										

BSCH824	Solid State Chemistry	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basics of Physical Chemistry				
Co-requisites	--				

Course Objectives

1. To be able to explain the peculiar properties of crystalline state, and the defects present in them.
2. To learn about electronic structure of metals and the concept of bands.
3. To understand the theory behind optical and electron microscopy techniques which are used to characterise solids.
4. To understand the kinetics of solid state reactions.

Course Outcomes

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

CO1. Describe the principles concerning solid state structures.

CO2. Deduce specific crystal structures by applying basic crystallographic concepts.

CO3. Understand different methods that are employed in solid state reactions.

CO4. Understand the presence of various defects in the crystal and its thermodynamics.

CO5. Classify materials into metals, insulators and semiconductors based on the energy gap.

CO6. Learn about the working principle of microscopic techniques that can be used to study solid surfaces.

Catalog Description

This course imparts the basic concepts of solid state chemistry and crystalline structure. It enables the students to study the solid state reactions and their experimental procedures. The course discusses the electronic and optical properties of solids. It also discusses about the presence of various defects in crystals and their thermodynamics.

Course Content

Unit I: 18 Lectures

Solid state Reactions

General principles, experimental procedure, co-precipitation as a precursor to solid reactions, kinetics of solid state reactions.

Unit II: **12 Lectures**

Crystal Defects and Non-stoichiometry

Perfect and imperfect crystals, intrinsic and extrinsic defects-point defects, line and plane defects, vacancies-schottky defects and Frenkel defects. Thermodynamics of Schottky and Frenkel defect formations. Colour centres, non-stoichiometry and defects.

Unit III: **12 Lectures**

Electronic properties and Band Theory

Metals, insulators and semiconductors, electronic structure of solids, band theory, band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors. Doping semiconductors, superconductors.

Unit IV: **1 8 Lectures**

Optical properties

Application of optical and electron microscopy. Magnetic properties-Classification of materials: Effect of temperature. Calculation of magnetic moment, mechanism of ferro and anti-ferromagnetic ordering super exchange.

Text Books

1. H V Keer, Principles of Solid state (Wiley Eastern)
2. L E Smart, E A Moore, Solid State Chemistry: An Introduction (World Scientific Publishing)

Reference Books/Materials

1. A. R. West, Solid state Chemistry and its Applications (Peenum)
2. D K Chakrabarty, Solid state Chemistry (New Wiley Eastern)

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	Describe the principles concerning solid state structures.	**PO1**
CO2	Deduce specific crystal structures by applying basic crystallographic concepts.	**PO2**
CO3	Understand different methods that are employed in solid state reactions.	**PSO4**
CO4	Understand the presence of various defects in the crystal and its thermodynamics.	**PSO1**
CO5	Classify materials into metals, insulators and semiconductors based on the energy gap.	**PO3**
CO6	Learn about the working principle of microscopic techniques that can be used to study solid surfaces.	**PSO2**

		Apply knowledge of chemistry to become proficient teacher	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 824	Solid State Chemistry	3	3	3	3			1	1	1	1	2	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**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1	**3**														
CO2		**3**													
CO3														**3**	
CO4											**3**				
CO5			**3**												
CO6												**3**			

BSCH858	Dissertation	L	T	P	C
Version 1.0		0	0	0	8
Total Contact Hours	60				
Pre-requisites/Exposure	Practical exposure				
Co-requisites	--				

Course Objectives

1. To learn how to carry out literature survey
2. To be associated with an area of research/research project and contribute towards domain knowledge.
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.

C02. 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 school for the supervision of the research work.
2. In the first week of Semester IV, 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 IV in regular consultation with his/her assigned faculty.
4. The student will write a dissertation based on the research work carried out during Semesters IV and prepare two copies to be submitted to the office of the Dean duly signed by the student and the supervisor at the end of IV semester or a date decided by the Dean.
5. Before preparing power point presentation and submission of dissertation, each student has to deliver presentation on his/ her research project work on a date fixed by Dean, 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.	PO5, PSO1, PSO2
CO2	Learn to write and present technical reports/articles.	PO7, PO8, PSO4, PSO5
CO3	Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.	PO2, PO4, PO6
CO4	Learn to analyze/evaluate the result of the experiment carried out and present the results using data visualization methods.	PO1, PO3, PO9, PO10

		Apply knowledge of chemistry to become proficient teacher about chemistry	Identify and resolve complex scientific research problems	Scrutinize problems using scientific tools for analysis and interpretation of data and to draw a logical conclusion	Select, plan and apply appropriate experimental techniques and IT tools to decipher chemical issues	Apply appropriate multi-disciplinary knowledge to resolve societal, health, safety, and cultural issues relevant to the science practices	Adopt green chemistry tools for sustainable development	Follow the ethical principles and responsibilities of a chemist to serve the society	Effective communication and presentation of data/project reports	Function effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings	Enhance employability skills as well as lifelong learning skills through activities such as seminar, conferences, industrial visits, internship, and dissertation etc.	Advanced knowledge of all aspects of chemistry	Understand complex chemical structures, instrumentation and separation techniques	Appreciate the importance and applications of various chemicals in day today life	Global level research opportunities	Enormous job opportunities in chemical, pharmaceutical, food product, and other industries
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCH 858	Dissertation	3	3	3	3	3	3	3	3	3	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**	**PO 10**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**
CO1					**3**						**3**	**3**			
CO2							**3**	**3**						**3**	**3**
CO3		**3**		**3**		**3**									**3**
CO4	**3**		**3**						**3**	**3**					