ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF APPLIED & PURE SCIENCES

(RSAPS)

DEPARTMENT OF CHEMISTRY

COURSE STRUCTURE & SYLLABUS

(BASED ON NATIONAL EDUCATION POLICY 2020)

FOR

B.Sc. IN CHEMISTRY

(4 YEARS SINGLE MAJOR)

W.E.F

AY - 2025 – 26

Course Structure & Framework

Table 6. Semester wise and component wise distribution of credit (Four Year UGP - Single Major) [6]

1st SEMESTER			
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**CREDIT**
Major (Core)	CHY012M101	General Chemistry-I	3
	CHY012M112	Chemistry Lab-I	3
Minor	CHY012N101	Fundamentals of Chemistry	3
Interdisciplinary (IDC)	IKS992K101	Introduction to Indian Knowledge System - I	3
Ability Enhancement course (AEC)	CEN982A101	CEN I: Introduction to Effective Communication	1
	BSH982A102	Behavioural Science-I	1
Skill Enhancement Course (SEC)	CHY012S111	Preparation and Estimation Techniques	3
Value Added Course (VAC)	VAC-1	Basket Course	3
		Swayam/MOOCS	4/5/6
TOTAL CREDIT FOR 1st SEMESTER			20 + 4/5/6

2nd SEMESTER			
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**CREDIT**
Major (Core)	CHY012M201	General Chemistry-II	3
	CHY012M212	Chemistry Lab-II	3
Minor	CHY012N201	General Chemistry Lab-I	3
IDC	IKS992I201	Introduction to Indian Knowledge System - II	3
AEC	CEN982A201	CEN II: Approaches to Verbal and Non-Verbal Communication	1
	BHS982A202	Behavioural Sciences -II	1
SEC	CHY012S211	Basic Preparative Techniques in Chemistry and Food Analysis	3
VAC	VAC-2	Basket Course	3
		Swayam/MOOCS	4/5/6
TOTAL CREDIT FOR 2nd SEMESTER			20 + 4/5/6
3rd SEMESTER			
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**CREDIT**

Major (Core)	CHY012M301	Organic Chemistry-I	4
	CHY012M311	Chemistry Lab - III	4
Minor	CHY012N301	Physical & Organic Chemistry	4
IDC	IDC-3	Basket Course	3
AEC	CEN982A301	CEN III – Fundamentals of Business Communication	1
	BHS982A302	Behavioural Sciences -III	1
SEC	CHY012S311	Analytical Laboratory Methods	3
		Swayam/MOOCS	4/5/6
TOTAL CREDIT FOR 3rd SEMESTER			20 + 4/5/6
4th SEMESTER			
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**CREDIT**
Major (Core)	CHY012M401	Inorganic Chemistry-I	4
	CHY012M402	Physical Chemistry-I	4
	CHY012M413	Chemistry Lab-IV	4

Minor	CHY012N401	Organic & Inorganic Chemistry	3
	CHY012N412	General Chemistry Lab-II	3
AEC	CEN982A401	CEN IV: Business Communication: Concepts and Skills	1
	BHS982A402	Behavioural Sciences - IV	1
		Swayam/MOOCS	4/5/6
		TOTAL CREDIT FOR 4th SEMESTER	20 + 4/5/6
5th SEMESTER			
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**CREDIT**
Major (Core)	CHY012M501	Organic Chemistry-II	4
	CHY012M502	Inorganic Chemistry II	4
	CHY012M503	Physical Chemistry II	4
Minor	CHY012N501	Inorganic & Physical Chemistry	4
Internship			4
20			
6th SEMESTER			

COMPONENT	COURSE CODE	COURSE TITLE	CREDIT
Major (Core)	CHY012M601	Spectroscopy	4
	CHY012M602	Quantum Chemistry	4
	CHY012M603	Introduction to Environmental and Green Chemistry	4
	CHY012M604	Analytical Chemistry	4
Minor	CHY012N601	Concepts of Analytical Chemistry	4
TOTAL CREDIT FOR 6th SEMESTER			20
7th SEMESTER			
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**CREDIT**
Major (Core)	CHY012M701	Organic Chemistry III	4
	CHY012M702	Physical Chemistry III	4
	CHY012M703	Inorganic Chemistry-III	4
	CHY012M704	Name Reactions & Reagents in Organic Chemistry	4

Minor	CHY012N701	Chemistry in Everyday Life	4
TOTAL CREDIT FOR 7th SEMESTER			20
8th SEMESTER			
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**CREDIT**
Major (Core)	CHY012M801	Advanced Instrumental Techniques	4
Minor	CHY012N801	Research Methodology	4
Dissertation /Research Project	CHY012M821	Research Project	12
Or 400 level advanced course Core (in lieu of Dissertation/Research project)	CHY012M802	Industrial and Polymer Chemistry	4
	CHY012M803	Material Chemistry	4
	CHY012M804	Biochemistry and Natural Products	4
TOTAL CREDIT FOR 8th SEMESTER			20

Detailed Syllabus

SYLLABUS (1st Semester)		
Subject Name: General Chemistry-I	**Level: 100**	**Subject Code: CHY012M101**
L-T-P-C: 3-0-0-3	**Credit Units: 3**	**Scheme of Evaluation: T**

Objective: The objective of **Chemistry-I** is to provide basic understanding and application of structure of atom and periodicity of atoms along with their bonding prospective to form compounds, also a brief idea of their acid and base properties. In this paper students will also be provided with basic idea of organic chemistry.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** and get the detailed idea of atomic structure, their periodicity and chemical bonding along with acid base properties	BT1
CO2	**Explain** the principle and apply the knowledge for solving the problems related to their structure and bonding.	BT2
CO3	**Apply** the idea to interpret changes of properties along the periods and group	BT3
CO4	**To get** information about basic organic chemistry	BT4

Detailed Syllabus:

Modules	Topics & Course Content	Periods
I	**Fundamentals of Atomic Structure** Basic quantum mechanical ideas and principles leading to atomic structure, black body radiation, Planck's hypothesis, wave character of particles- electron diffraction, discrete nature of energy levels of atomic and molecular systems, line spectra of atoms and molecules, de Broglie hypothesis, uncertainty principle. Schrödinger wave equation, significance of ψ and ψ^2, quantum numbers, radial and angular distribution curves, shapes of *s*, *p*, *d* and *f* orbitals, probability diagrams, Pauli's exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle, variation of orbital energy with atomic number.	**15**

II	**Periodicity of Elements** s, p, d, f block elements, the long form of periodic table, detailed discussion of the following properties: effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table, atomic radii (van der Waals), ionic and crystal radii, covalent radii, ionization enthalpy, electron gain enthalpy, electronegativity: Pauling's, Mulliken's, Allred Rachow's and Mulliken-Jaffe's electronegativity scales, variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.	**15**
III	**Chemical Bonding I** Ionic bonding: size effects, packing of ions in crystals, lattice energy, Born-Lande equation and its applications, Born-Haber cycle and its applications. Solvation energy, polarizing power and polarizability, ionic potential, Fazan's rule. Covalent bonding: Lewis structures, formal charge. Valence bond theory, directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs, bond moment and dipole moment, concept of resonance, resonance energy, resonance structures.	**15**
IV	**Introduction to organic compounds** Unique properties of organic compounds, sources of organic compounds, classification of organic compounds on the basis of their functional groups, homologous series, IUPAC nomenclature for organic compounds with single and multiple functional groups, chain, position and functional group isomerism, special types of organic compounds. Covalent bond, hybridization of carbon in organic compounds, orbital representation of methane, ethane, ethyne and benzene.	**15**
TOTAL		**60**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
60 hrs	--	30 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. *Concise Inorganic Chemistry*; Lee, J.D.; 5th edition; 2013; John Wiley and Sons Ltd.; Indian Edition.
2. *Inorganic Chemistry Principles of Structure and Reactivity*; Huheey, J.E., Keiter, E. A., Keiter, R. L. and Medhi, O. K. ; 4th edition; 2007; Pearson Education.
3. Organic Chemistry, Morrison R. T. and Boyd R.N., Bhattacharjee S.K.B., 6th edition, 2017, published by Prentice Hall.

Reference Books:

1. *Inorganic Chemistry*; Atkins, P., Overtone, T., Rourke, J., Weller, M. and Armstrong, F.; 6th edition; 2014; Oxford University Press; Indian edition.
2. Cotton F.A., Wilkinson, G., Murillo A., Bochmann M.; *Advanced Inorganic Chemistry;* 6th edition; 2007; Wiley Inter science; New York
3. Sykes, P. *A guide book to mechanisms in Organic Chemistry*, 6th edition, 2003, Pearson India.

SYLLABUS (1st Semester)

Subject Name: Chemistry Lab-I	**Level: 100**	**Subject Code: CHY012M112**
L-T-P-C–0-0-6-3	**Credit Units: 3**	**Scheme of Evaluation: P**

Objective: The objective of Chemistry Lab I is to provide the knowledge of estimation of chemical species with titrimetric, viscometric and kinetic analysis as well as practical experience of inorganic compound synthesis.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Show** the preparation of inorganic compounds and salt.	BT1
CO2	**Demonstrate** the estimation the impurities in water and inorganic compounds in solutions.	BT2
CO3	**Experiment** with various techniques to determine the chemical elements present in sample.	BT3
CO4	**Compare** the viscosity, surface tension of unknown solutions and to inspect the rate of reaction.	BT4

Detailed Syllabus:

1. Preparation of following Inorganic compounds:
   a) Chrome alum, $K_2SO_4.Cr_2(SO_4)_3.24H_2O$
   b) Ferrous ammonium sulfate or Mohr salt, $FeSO_4.(NH_4)_2SO_4.6H_2O$
2. To determine the total hardness of water by titration with EDTA
3. Estimation of Ferrous ion Fe(II) using $KMnO_4$ solution
4. Estimation of copper by using standard solution of sodium thiosulphate
5. To determine the water of crystallization of green vitriol by titration of its prepared solution with $KMnO_4$ solution
6. To determine the coefficient of viscosity of a given liquid by Ostwald viscometer.
7. To determine the composition of a given mixture by viscosity method.

8. To determine the surface tension of a liquid by stalagmometer.
9. To determine the composition of a given mixture by surface tension method.
10. To determine the specific reaction rate of hydrolysis of methyl acetate catalysed by hydrogen ions at room temperature.
11. To study the rate of acid catalysed iodination of acetone.

Text Books:

1. *A text Book of Practical Chemistry*, Barua, S, 2th edition; 2016; Kalyani Publishers.
2. *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7thedition; Pearson.

Reference Books:

1. Mendham J., Denney R.C., Barnes J.D. and. Thomas M. J. K.; *Vogel's Textbook of Quantitative Chemical Analysis*, 6th edition, 3rd Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi
2. Halpern, M.; *Experimental Physical Chemistry*, 6th edition, 2008; Prentice Hall, Upper Saddle River, NJ07458.

SYLLABUS (1st Semester)

Subject Name: Fundamentals of Chemistry	**Level: 100**	**Subject Code: CHY012N101**
L-T-P-C: 3-0-0-3	**Credit Units: 3**	**Scheme of Evaluation: T**

Objective: The objective of **Fundamentals of Chemistry** is to make students familiar with origin of quantum theory and atomic structure. It will help students to understand the bonding and structure of molecules, and also evaluate acidic-basic character of compounds.

Course Outcomes:

After successful completion of the course, student will be able to

Sl No	Course Outcomes	Bloom's Taxonomy Level
CO1	**Recall** the concepts of quantum theory.	BT1
CO2	**Explain** the theories of chemical bonding.	BT2
CO3	**Apply** the concept of hybridization to geometry.	BT3
CO4	**Examine** the compounds to determine the chemical components present in sample.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Fundamentals of atomic structure** Origin of Quantum theory (black body radiation, heat theory, H-atom spectra, photo-electric effect), calculations based on Bohr's theory of H-atom – atomic spectra of hydrogen atom, wave-particle duality, de Broglie hypothesis, Heisenberg's uncertainty principle. Schrödinger wave equation, significance of ψ and ψ^2, quantum numbers, radial and angular distribution curves, shapes of *s*, *p*, *d* and *f* orbitals, probability diagrams, Pauli's exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle, variation of orbital energy with atomic number.	**15**
II	**Chemical Bonding** Ionic bonding: Size effects, radius ratio rules and their limitations, lattice energy, Born-lande equation and its applications, Born-Haber cycle. Covalent bonding: Valence bond theory, hybridizations, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs, dipole moment, electronegativity.	**15**
III	**Structure and bonding of Organic compound** Hybridization, localized and delocalized chemical bond, resonance, conditions of resonance, Electronic displacements: inductive effect, electrometric effect, mesomeric effect &hyperconjugation, nature of fission of covalent bond, type of reagents: nucleophiles and electrophiles, Reaction intermediates: carbocations, carbanions, free radicals, carbenes, nitrenes, and benzynes.	**15**
IV	**Acid-Base concept** Arrhenius concept, Bronsted-Lowry's concept, relative strength of acids, Pauling rules, amphoterism, Lewis concept, superacids, HSAB principle, acid base equilibria in aqueous solution and pH, acid-base neutralisation curves.	**15**
Total		**60**

List of Experiments:

1) To determine the strength of the given glucose solution by titrating with Fehling's solution.
2) Estimation of Ferrous Iron, Fe (II) using potassium permanganate solution.
3) Estimation of copper by using standard solution of sodium thiosulphate ($Na_2S_2O_3$)

4) To determine the coefficient of viscosity of the given liquid at a given concentration by using Ostwald's viscometer.

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
60 hrs	--	30 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. *Organic Chemistry*, Morrison R. T. and Boyd R. N., Bhattacharjee S.K.B.,6th edition, 2011, published by Prentice Hall.
2. *A text Book of Practical Chemistry*, Barua, S, 2th edition; 2016; Kalyani Publishers.

Reference Books:

1. Huheey, J.E. Keiter, E.A. Keiter, R.L Medhi, O.K.; *Inorganic Chemistry Principles of Structure and Reactivity*; 4th edition, 2006; Pearson Education.
2. Sen, B.K.; Quantum Chemistry Including Spectroscopy; 4th edition; 2018; Kakyani Publishers, New Delhi.
3. Vogel's Qualitative Inorganic Analysis; Svehla G. and Sivasankar B.; 7thedition Pearson.

SYLLABUS (1st Semester)			
Subject Name: Introduction to Indian Knowledge System - I			**Subject Code: IKS992K101**
LTPC: 2-1-0-3	**Credit: 3**	**Level: 100**	**Scheme of Evaluation: T**

Objective: This Foundation course is designed to present an overall introduction to all the streams of IKS relevant to the UG program. It would enable students to explore the most fundamental ideas that have shaped Indian Knowledge Traditions over the centuries.

Course Outcomes:

On completion of this course students will be able to –

Sl No	Course Outcomes	Bloom's Taxonomy Level
CO1	**Recall** the rich heritage of Indian knowledge systems	BT1
CO2	**Describe** the contribution of Indian knowledge systems to the world	BT2

CO3	**Demonstrate** knowledge of sociocultural and ethnolinguistic diversity that constitutes the soul of Bharatvarsha	BT2
CO4	**Apply** traditional knowledge and techniques in day-to-day life	BT3
CO5	**Distinguish** knowledge traditions that originated in the Indian subcontinent	BT3

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Introduction to Indian Knowledge Systems (IKS):** -What is the Indian Knowledge System? -Definition of Indigenous/ Traditional Knowledge -Scope, and Importance of Traditional Knowledge. **Ancient India- Bharat Varsha:** -People of Ancient Bharat Varsha -Our great natural heritage: The great Himalayas and the rivers. - The civilizations of the Sindhu-Ganga valley, and the Brahmaputra valley. -Our coastal plains. -Our Nature: Forests and Minerals -Ancient Indian Traditional Knowledge and Wisdom about nature and climate.	**15**
II	**Indian Heritage of Knowledge:** -Ancient Indian Knowledge: The *Vedas* and its components-the *Vedangas* -Ancient Indian books and treaties: The *Sastras*. -The Great Indian Epics: The Ramayana and The Mahabharata, -Epics and religious treaties of ancient Assam: Introduction to Madhav Kandali's *Ramayan* and Srimanta Sankardev's *Dasam Skandha Bhagavat* of the Puranas. -Ancient Traditional Knowledge-The *Agamas* -The ancient Buddhist knowledge: *Tripitaka: Vinaya, Sutta* and *Abhidhamma Pitaka* **Languages and language studies in India:** -What is linguistics? -Script and Language	**15**

	-Alphabet of the Indian languages *Varnamala:* Origin, Evolution, and phonetic features. -Languages of India -Important texts of Indian languages: Skills *Siksha,* Expression/Prounciation-*Nirukta,* Grammer-*Vyakarana,* Poetic rhythm-*Chandas.* -Paninian Grammar: A Brief Introduction **Introduction to Fine Arts and Performing Arts of India:** -Ancient Indian classical music and dance forms: The Science of Dramas-*Natyasastra* and the Science of Music-*Gandharva-Veda.* -*Aesthetics in Indian Art and Culture.* -Folk music and traditional dance forms of the Northeast.	
III	**Indian Science & Technology** -Ancient India's contribution to Mathematics- Number System. Algebra and Arithmetic, Geometry and Trigonometry. -Origin of Decimal system in India; nomenclature of numbers in the Vedas. Zero and Infinity. Sulba-sutras. Contribution of Brahmagupta and Sridhar Acharya to Mathematics. Important texts of Indian mathematics. • **Indian Astronomy:** Planetary System. Motion of the Planets. Velocity of Light. Eclipse. Astronomy. Navagrahas. Important works in Indian Astronomy. Aryabhata and Nilakantha: Contribution to Astronomical Studies • **Indian Metal Works:** Mining Techniques. Types of Metals. Tools & Techniques for Metal Smelting with examples. Metalworks in pre-modern India: Special reference to NE India.	**15**
IV	**Contribution of Ancient India to Health Sciences:** -Traditional Indigenous systems of medicines in India: - *Ayurveda* and *Yoga:* Elements of *Ayurveda: Gunas* and *Doshas*, *Pancha Mahabhuta* and *Sapta-dhatu*. -Concept of disease in Ayurveda -Ayurvedic lifestyle practices: *Dinacharya* and *Ritucharya.* -Important Ayurvedic Texts -Hospitals in Ancient India • -*Ayurveda*: Gift of India to the modern world.	**15**
	The experiential learning sessions may include: • Field Visits: Organizing visits to historical sites, museums, traditional craft centers, and other places relevant to Indian knowledge systems.	

EL	• Interactive Sessions: Engaging students in discussions with experts and practitioners in various fields of Indian knowledge systems to gain insights and practical knowledge. • Online Lecture Series: Providing the students with online lectures by distinguished experts in the field of the Indian Knowledge System. • Hands-on Activities: Providing opportunities for students to participate in activities related to traditional arts, crafts, music, dance, agriculture, etc., to understand the practical aspects of Indian knowledge systems. • Practical Demonstrations: Conducting workshops or sessions to demonstrate traditional practices, such as yoga, Ayurveda, Vastu Shastra, etc., for the students.	**30**
	Total	**90**

Credit Distribution		
L/T	**Practicum**	**Experimental Learning**
60 hrs	**--**	30 hrs

Text Books:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavan RN. (2022), *Introduction to Indian Knowledge System: Concepts and Applications.* PHI Learning Private Ltd.
2. Mukul Chandra Bora*, Foundations of Bharatiya Knowledge System.* Khanna Book Publishing.

Reference Books:

1. Baladev Upadhyaya, *Samskrta Śāstrom ka Itihās*, Chowkhambha, Varanasi, 2010.
2. D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., *A Concise History of Science in India*, 2nd Ed., Universities Press, Hyderabad, 2010.
3. Astāngahrdaya, Vol. I, *Sūtrasthāna and Śarīrasthāna*, Translated by K. R. Srikantha Murthy, Vol. I, Krishnadas Academy, Varanasi, 1991.
4. Dharampal, *The Beautiful Tree: Indian Indigenous Education in the Eighteenth Century*, Dharampal Classics Series, Rashtrotthana Sahitya, Bengaluru, 2021.
5. J. K. Bajaj and M. D. Srinivas, *Indian Economy, and Polity in Eighteenth-century Chengalpattu*, in J. K. Bajaj ed., Indian Economy and Polity, Centre for Policy Studies, Chennai, 1995, pp. 63-84.

SYLLABUS (1st Semester)			
Subject Name: CEN I: Introduction to Effective Communication			**Subject Code: CEN982A101**
LTPC: 1-0-0-1	**Credit: 1**	**Level: 100**	**Scheme of Evaluation: T & P**

Course Objective: To understand the four major aspects of communication by closely examining the processes and outlining the most effective ways to communicate with interactive activities.

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

CO Level	Course Outcome	Blooms Taxonomy Level
CO1	**List** the elements and processes that make for successful communication and **recognise** everyday activities that deserve closer attention in order to improve communication skills	**BT 1**
CO2	**Contrast** situations that create barriers to effective communication and **relate** them to methods that are consciously devised to overcome such hindrance	**BT 2**
CO	**Apply** language, gestures, and para-language effectively to avoid miscommunication and **articulate** one's thoughts and build arguments more effectively	**BT 3**

Detailed Syllabus		
Units	**Course Contents**	**Periods**
I	Introduction to Effective Communication • Listening Skills o The Art of Listening o Factors that affect Listening o Characteristics of Effective Listening o Guidelines for improving Listening skills	**5**
II	• Speaking Skills o The Art of Speaking o Styles of Speaking o Guidelines for improving Speaking skills o Oral Communication: importance, guidelines, and barriers	**5**

III	• Reading Skills o The Art of Reading o Styles of Reading: skimming, surveying, scanning o Guidelines for developing Reading skills	**5**
IV	• Writing Skills o The Art of Writing o Purpose and Clarity in Writing o Principles of Effective Writing	**5**

Text Books:

1. Rizvi, M. Ashraf. (2017). *Effective Technical Communication*. McGraw-Hill.
2. Chaturvedi, P. D. and Chaturvedi, Mukesh. (2014). *Business Communication.* Pearson.
3. Raman, Meenakshi and Sharma, Sangeeta. (2011). *Technical Communication: Principles and Practice* (2nd Edition): Oxford University Press.

Credit Distribution		
Lecture/Tutorial	**Practicum**	**Experiential Learning**
15 hours	-	10 hours - Movie/ Documentary /Podcasts screening - Peer teaching

SYLLABUS (1st Semester)

Subject Name: Behavioural Science - I **Subject Code: BSH982A102**

LTPC: 1-0-0-1 **Credit: 1** **Level: 100** **Scheme of Evaluation: T**

Course objectives: To increase one's ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations.

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

CO Level	Course Outcome	Blooms Taxonomy Level
CO1	Understand self & process of self-exploration.	**BT 1**

CO2	Learn about strategies for development of a healthy self esteem	**BT 2**
CO3	Apply the concepts to build emotional competencies.	**BT 3**

Detailed Syllabus:

Modules	Course Contents	Periods
I	**Introduction to Behavioral Science** Definition and need of Behavioral Science,Self: Definition components, Importance of knowing self, Identity Crisis,Gender and Identity, Peer Pressure, Self image: Self Esteem, Johari Window ,Erikson's model.	**4**
II	**Foundations of individual behavior** Personality- structure, determinants, types of personalities. Perception: Attribution, Errors in perception. Learning- Theories of learning: Classical, Operant and Social	**4**
III	**Behaviour and communication.** Defining Communication, types of communication, barriers to communication, ways to overcome barriers to Communication, Importance of Non-Verbal Communication/Kinesics, Understanding Kinesics, Relation between behaviour and communication.	**4**
IV	**Time and Stress Management** Time management: Introduction-the 80:20, sense of time management, Secrets of time management, Effective scheduling. Stress management: effects of stress, kinds of stress-sources of stress, Coping Mechanisms. Relation between Time and Stress.	**4**
Total		**16**

Text books:

1. J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 3, Management; Pfeiffer &Company
2. Blair J. Kolasa, Introduction to Behavioural Science for Business, John Wiley & Sons Inc
3. K. Alex, Soft skills; S. Chand.

SYLLABUS (1st Semester)			
Subject Name: Preparation and Estimation Techniques			**Subject Code: CHYO12S111**
LTPC: 0-0-6-3	**Credit: 3**	**Level: 100**	**Scheme of Evaluation: P**

Objective:

The objectives of **Preparation and Estimation techniques** are to make students familiar with organic and inorganic preparation methods with hands on practical. It will also improve the understanding of the concepts of estimation and separation processes.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** and gain the preparation knowledge of inorganic compounds.	BT1
CO2	**Explain** the concept of organic synthesis methods	BT2
CO3	**Apply** the knowledge of chromatography in separation of compounds.	BT3
CO4	**Analyse** and **Estimate** the species present by gravimetry.	BT4

1. **Preparation of following Inorganic compounds**:
   I. Potash alum
   II. Sodiumtrioxalatoferrate(III)
2. **Preparation of following Organic compounds**:
   I. Aspirin
   II. *p*-Bromoaniline
3. **Chromatography**:
   I. To separate and identify the amino acids by ascending paper chromatography.
   II. To separate and identify the sugars by ascending paper chromatography.
   III. Separation of a mixture of dyes by column chromatography.

4. Gravimetry

I. Estimation of Silver

II. Estimation of Barium

III. Estimation of Sulphate

5. Demonstration of UV-Vis Spectrophotometer

Text Books:

1. A text Book of Practical Chemistry, Barua, S, 2th edition; 2016; Kalyani Publishers.

2. Vogel's Qualitative Inorganic Analysis; Svehla G. and Sivasankar B.; 7th edition; Pearson.

Reference Books:

1. Mendham J., Denney R.C., Barnes J.D. and. Thomas M.J.K.; *Vogel's Textbook of Quantitative Chemical Analysis*, 6th edition, 3rd Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi
2. V*ogel's Textbook of Practical Organic Chemistry*, Vogel A.I., Aurther I., 5th Edition, 2005, Pearson

SYLLABUS (2nd Semester)

Subject Name: General Chemistry-II	**Level: 100**	**Subject Code: CHY012M201**
L-T-P-C: 3-0-0-3	**Credit Units: 3**	**Scheme of Evaluation: T**

Course Objective: The objective of **General Chemistry-II** is to understand and apply the concepts of classical thermodynamics. It will also provide knowledge related to the fundamental concepts on organic parameters which is required to rationalize and predict the chemical reactivity

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** and gain the knowledge from laws of thermodynamics to solve the complex problems of physical chemistry	BT1
CO2	**Explain** the concept of thermodynamical parameters and their importance to interpret the spontaneity of reaction.	BT2
CO3	**Apply** the knowledge of chemical kinetics and analyze chemical reactions and reaction mechanism.	BT3
CO4	**Illustrate** different parameters like aromaticity, inductive effect, etc. which is vital to understand the chemical reaction	BT4

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Chemical Thermodynamics-I** Terminology used in thermodynamics (system, surroundings, extensive and intensive properties, state and path functions), concept of heat and work. *First law:* Internal energy, statement first law, Calculation of w, q, ΔU & ΔH for expansion of ideal gases under isothermal and adiabatic conditions for reversible and irreversible processes, heat capacity and relation between C_p&C_v, Joule-Thomson experiment, relation between P,V and T in adiabatic processes, limitations of first law. *Thermochemistry:* Heats of reactions: standard enthalpy changes, Hess's Law of heat summation and its applications, calculation of bond dissociation energy from thermochemical data, effect of temperature on enthalpy of reactions (Kirchhoff's equation).	**15**
II	**Chemical Thermodynamics-II** *Second Law*: Different statements of the law, Cornot's cycle and its efficiency, Carnot's theorem *Concept of entropy*: Entropy as a criterion of spontaneity and equilibrium, entropy change for an ideal gas, entropy of phase transitions, entropy of mixture of ideal gas, entropy of mixing. *Gibbs and Helmholtz functions:* Gibbs function (G) and Helmhotz (work) function (A) as thermodynamic quantities, criteria of spontaneity, variation of G with T and P, Maxwell relations, Gibbs-Helmholtz equation	**15**
III	***Third law*: Nernst heat theorem, statement of third law, residual entropy.** Equilibrium constant, thermodynamic derivation of law of mass action, equilibrium constant of a reaction in terms of standard Gibb's free energy, relation between K_p and K_c, Le Chatelier principle, van't Hoff isotherm and isochore, Clapeyron-Clausius equation and its applications.	**15**
IV	**Chemical Bonding and structure of organic molecules** Bond angles, bond length and bond energies, resonances or mesomeric effect and aromaticity, tautomerism, hydrogen bonding and its effect on the properties, polarity of bonds. Structural effects like inductive, resonance, hyper conjugation, steric effect and their influence on acidity and basicity of organic compounds, pKa and pK values of common organic acids and bases.	**15**
	Total	**60**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
60 hrs	-	30 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. *Physical Chemistry*, Atkins P. W.and Paula J. de; 11th edition; 2018; Oxford University Press.
2. *Principles of Physical Chemistry*; Puri, B.R.; Sharma, L.R.; Pathania, M.S.; 48th edition; 2020; Vishal PublishingCompany.
3. *Organic Chemistry*, Stanley H. Pine, 5th edition,2014, McGraw-Hill Bool.
4. *Organic Chemistry*, Solomons T.J., 11th Revised edition,2013, John Wiley & Sons Inc.

Reference Books:

1. Glasstone, S.; *Text book of Physical Chemistry;* 11th edition; 2011; Van Nostr and company.
2. Atkins, P.W. and Paula, J. de; *Elements of Physical Chemistry;*7th edition; 2018; Oxford UniversityPress.
3. Kapoor, K. L.; *A textbook of Physical chemistry*; 8th edition,; 2018; Macmillan, India Ltd.
4. Bokris, J.A. and Reddy, A.K.N; *Modern Electrochemistry*; Vols. 1&2; Kluwer AcademicPublishers
5. *Organic Chemistry*, Morrison R. T. and Boyd R.N., Bhattacharjee S.K.B., 6th edition, 2017, published by Prentice Hall.

SYLLABUS (2ndSEMESTER)

Subject Name: Chemistry Lab II **Level: 100** **Subject Code: CHY012M212**

L-T-P-C: 0-0-6-3 **Credit Units: 3** **Scheme of Evaluation: P**

Course Objective: The objective of **Chemistry Lab II** is to improve the understanding of the theoretical concepts and application of organic chemistry as well as to grow the practical knowledge.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** the techniques that are useful in modern applied chemistry.	BT1
CO2	**Interpret** analytical abilities for independent thinking.	BT2

CO3	**Make use** of the functional group analysis of simple organic compounds to synthesize different derivatives of simple organic molecules	BT3
CO4	**Distinguish** different methods for the preparation of complexes	BT4

Detailed Syllabus:

A. Qualitative analysis of organic sample should be done by each student.

1. Detection of special elements (N, Cl, S) by Lassaigne's test
2. Solubility and Classification (solvents: H_2O, 5% HCl, 5% $NaHCO_3$, 5%NaOH)
3. Detection of the following functional groups by systematic chemical tests: Aromatic amino ($-NH_2$), aromatic nitro ($-NO_2$), amido ($-CONH_2$, including imide), Phenolic – OH, Carboxylic acid (-COOH), Carbonyl (>C=O); only one test foreach functional group is to be reported along with confirmatory test, if any exists there.
4. Preparation of derivative and purification by crystallization
5. Determination of M.P. of the given sample and its derivative

   Each student, during laboratory session, is required to carry out qualitative chemical tests for all the special elements and the functional groups in known and unknown (at least 5)

B. The following preparations are to be done by each student in class. Any one of these will be required to be done in the examination.

1. Acetylation: Preparation of acetanilide from aniline OR preparation of aspirin from salicylic acid (any one).
2. Nitration: Preparation of m-dinitrobenzene from nitrobenzene OR preparation of p- nitro acetanilide from acetanilide (any one).
3. Preparation of benzanilide from aniline

C. Purification of mixture of amino acids by Paper Chromatography

D. To determine the strength of a given glucose solution by Fehling's solution

Text Book:

1. *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7thedition; Pearson.
2. V*ogel's Textbook of Practical Organic Chemistry*, Vogel A.I., Aurther I., 5thEdition, 2005,Pearson.

Reference Books:

1. Agarwal O. P., *Advanced Practical Organic Chemistry*, 2nd Edition, 2014, Goel Publishing.

SYLLABUS (2ndSEMESTER)

Subject Name: General Chemistry Lab-I	**Level: 100**	**Subject Code: CHY012N201**
L-T-P-C: 0-0-6-3	**Credit Units: 3**	**Scheme of Evaluation: P**

Course Objective: The objective of **General Chemistry Lab-I** is to provide the knowledge of volumetric estimation and qualitative analysis of organic compounds as well as practical experience of organic compound analysis.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** the techniques that are useful in analytical chemistry	BT1
CO2	**Demonstrate** the estimation of Ferrous Iron, Fe (II) and copper	BT2
CO3	**Apply** the knowledge of organic chemistry to analyse the functional group analysis of simple organic compounds to synthesize different derivatives of simple organic molecules.	BT3
CO4	**Inspect** and determine the strength of glucose solution	BT4

Detailed Syllabus:

1) To determine the strength of the given glucose solution by titrating with Fehling's solution.
2) Estimation of Ferrous Iron, Fe (II) using potassium permanganate solution.
3) Estimation of copper by using standard solution of sodium thiosulphate ($Na_2S_2O_3$)
4) Qualitative organic analysis:
   a) Detection of N, S, and halogens in organic compounds
   b) Detection of functional groups
   c) To determine the coefficient of viscosity of the given liquid at a given concentration by using Ostwald's viscometer.
5) To determine the surface tension by stalagmometer.

Text Book:

1. *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7th edition; Pearson.
2. *A text book of Practical Chemistry*, Barua, S, 2th edition; 2016; Kalyani Publishers.

Reference Books:

2. Agarwal O. P., *Advanced Practical Organic Chemistry*, 2nd Edition, 2014, Goel Publishing.

SYLLABUS (2nd Semester)			
Subject Name: Introduction to Indian Knowledge System - II			**Subject Code: IKS992I201**
LTPC: 2-1-0-3	**Credit: 3**	**Level: 100**	**Scheme of Evaluation: T**

Objective: This Foundation course is designed to present an overall introduction to all the streams of IKS relevant to the UG program. It would enable students to explore the most fundamental ideas that have shaped Indian Knowledge Traditions over the centuries.

Course Outcomes:

On completion of this course, students will be expected to –

Sl No	Course Outcomes	Bloom's Taxonomy Level
CO1	**Recall** traditional Indian knowledge traditions constituting Indian culture	BT1
CO2	**Summarize differences** between classical literature in Sanskrit and other Indian languages	BT2
CO3	**Compare** knowledge traditions originating in NE India	BT2
CO4	**Appreciate** the contribution of Indian Knowledge Systems to the world	BT3

Detailed Syllabus:

Modules	Topics / Course content	Periods
I.	**Indian Classical Literature** Indian Classical Literature: A Brief Introduction. - Ancient Indian Spritual Poetics-*Kavya*: Contribution of Kalidasa **Diversity and Indian Culture:** - Diversity and Indian Culture -Indigenous Faith and Religion -Preservation of culture and indigenous knowledge **The Purpose of Knowledge** - Understanding Self-Awareness and Spirituality. -Indian concept and purpose of Knowledge and Education - Understanding Spirituality and Materialism: *Para* and *Apara Vidya*	**15**
II.	**Methodology of Indian Knowledge System:** - *Shruti* and *Smriti* traditions. -Intoduction to *Shastras.* -Manuscriptology: The art and science of documenting knowledge. - Repositories of ancient manuscripts with special reference to the Norteast India. **Indian Architecture and Town Planning:** - Introduction ancient Indian architecture. - *Sthapatya-Veda*: An Introduction - Indigenous tools & techniques for town planning & Temple Architecture. Lothal, Mohan Jo Daro. - Temple Art: Lepakshi Temple, Jagannath Puri Temple, Konark Sun Temple. - Vernacular architecture of Assam: Special reference to Brahmaputra Valley	**15**
III.	**Indian Agriculture:** - Agriculture: Significance in Human Civilization. - Sustainable Agriculture. - Historical significance of agriculture and sustainable farming in India. - Step Cultivation of India: Special reference to Northeast India. - Wet rice cultivation of Assam. **Indian Textiles:** What is Textile?	**15**

	- Tradition of cotton and silk textiles in India. - The historical contribution of textile and weaving to the Indian economy. - Varieties of textiles and dyes developed in different regions of India with special reference to Northeast India	
IV.	**Indian Polity and Economy:** - Understanding Kingdom and Chiefdom - Role of a king - The Indian idea of a well-organized polity and flourishing economy. - The *Chakravarti* System: Administrative System of Ancient Bharatvarsha. - Village administrative system: Northeast India. - *Arthashastra*: Brief synopsis **The outreach of Indian Knowledge System across Geographical Boundaries** - Indian Languages. - Scripts. - Linguistics. - Ayurveda. - Yoga and Meditation. - Textile - Decimal value place system-based arithmetic, Algebra and Astronomy	**15**
EL	The experiential learning sessions may include: • Field Visits: Organizing visits to historical sites, museums, traditional craft centers, and other places relevant to Indian knowledge systems. • Interactive Sessions: Engaging students in discussions with experts and practitioners in various fields of Indian knowledge systems to gain insights and practical knowledge. • Online Lecture Series: Providing the students with online lectures by distinguished experts in the field of the Indian Knowledge System. • Hands-on Activities: Providing opportunities for students to participate in activities related to traditional arts, crafts, music, dance, agriculture, etc., to understand the practical aspects of Indian knowledge systems. • Practical Demonstrations: Conducting workshops or sessions to demonstrate traditional practices, such as yoga, Ayurveda, Vastu Shastra, etc., for the students.	**30**
	Total	**90**

Text Books:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavan RN. (2022), Introduction to Indian Knowledge System: Concepts and Applications. PHI Learning Private Ltd.
2. Mukul Chandra Bora, Foundations of Bharatiya Knowledge System. Khanna Book Publishing.

Reference Books:

1. Baladev Upadhyaya, *Samskrta Śāstrom ka Itihās*, Chowkhambha, Varanasi, 2010.
2. D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., *A Concise History of Science in India*, 2nd Ed., Universities Press, Hyderabad, 2010.
3. Astāngahrdaya, Vol. I, *Sūtrasthāna and Śarīrasthāna*, Translated by K. R. Srikantha Murthy, Vol. I, Krishnadas Academy, Varanasi, 1991.
4. Dharampal, *The Beautiful Tree: Indian Indigenous Education in the Eighteenth Century*, Dharampal Classics Series, Rashtrotthana Sahitya, Bengaluru, 2021.
5. J. K. Bajaj and M. D. Srinivas, *Indian Economy, and Polity in Eighteenth-century Chengalpattu*, in J. K. Bajaj ed., Indian Economy and Polity, Centre for Policy Studies, Chennai, 1995, pp. 63-84.

SYLLABUS (2nd Semester)

Subject Name: CEN II: Approaches to Verbal and Non-Verbal Communication			**Subject Code: CEN982A201**
LTPC: 1-0-0-1	**Credit: 1**	**Level: 100**	**Scheme of Evaluation: T & P**

Course Objectives

To introduce the students to the various forms of technical communication and enhance their knowledge in the application of both verbal and non-verbal skills in communicative processes.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO1	**List** the different types of technical communication, their characteristics, their advantages and disadvantages.	**BT 1**
CO2	**Explain** the barriers to communication and ways to overcome them.	**BT 2**
CO3	**Identify** the means to enhance conversation skills.	**BT 3**
CO 4	**Determine** the different types of non-verbal communication and their significance.	**BT 4**

Detailed Syllabus

Modules	Topics (if applicable) & Course Contents	Periods
I	**Technology Enabled Communication** Communicating about technical or specialized topics, Different forms of technology-enabled communication tools used in organizations Telephone, Teleconferencing, Fax, Email, Instant messaging, Blog, Podcast, Videos, videoconferencing, social media	**4**
II	**Communication Barriers** Types of barriers: Semantic, Psychological, Organisational, Cultural, Physical, Physiological, Methods to overcome barriers to communication.	**4**
III	**Conversation skills/Verbal Communication** Conversation – Types of Conversation, Strategies for Effectiveness, Conversation Practice, Persuasive Functions in Conversation, Telephonic Conversation and Etiquette Dialogue Writing, Conversation Control.	**4**
IV	**Non-verbal Communication** Body language- Personal Appearance, Postures, Gestures, Eye Contact, Facial expressions Paralinguistic Features-Rate, Pause, Volume, Pitch/Intonation/ Voice/Modulation, Proxemics, Haptics, Artifacts, Chronemics,	**4**
	Total	**16**

Text Books:

1. Rizvi, M. Ashraf. (2017). *Effective Technical Communication*. McGraw-Hill.
2. Chaturvedi, P. D. and Chaturvedi, Mukesh. (2014). *Business Communication.* Pearson.
3. Raman, Meenakshi and Sharma, Sangeeta. (2011). *Technical Communication: Principles and Practice* (2nd Edition): Oxford University Press.

SYLLABUS (2nd Semester)			
Subject Name: Behavioural Sciences -II			**Subject Code: BHS982A202**
LTPC: 1-0-0-1	**Credit: 1**	**Level: 100**	**Scheme of Evaluation: T**

Course objectives: To increase one's ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations.

Course outcomes: On completion of the course the students will be able to:

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	Develop an elementary level of understanding of culture and its implications on personality of people.	**BT 1**
CO 2	Understand the concept of leadership spirit and to know its impact on performance of employees.	**BT 2**
CO 3	Understand and apply the concept of Motivation in real life.	**BT 3**

Modules	Course Contents	Periods
I	**Culture and Personality** Culture: Definition, Effect, relation with Personality, Cultural Iceberg, Overview of Hofstede's Framework, Discussion of the four dimensions of Hofstede's Framework.	**4**
II	**Attitudes and Values** Attitude's definition: changing our own attitudes, Process of cognitive dissonance Types of Values, Value conflicts, Merging personal and Organisational values	**4**
III	**Motivation** Definition of motivation with example, Theories of Motivation (Maslow, McClelland's theory& Theory X and Y)	**4**
IV	**Leadership** Definition of leadership, Leadership continuum, types of leadership, Importance of Leadership, New age leaderships: Transformational & transactional Leadership, Leaders as role models.	**4**
Total		**16**

Text books:

1. J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 3, Management; Pfeiffer &Company
2. Blair J. Kolasa, Introduction to Behavioural Science for Business, John Wiley & Sons Inc.
3. Organizational Behaviour by Kavita Singh (Vikas publishers, 3rd Edition).

SYLLABUS (2nd Semester)(SEC)

Subject Name: Basic Preparative Techniques in Chemistry--And Food Analysis **Subject Code: CHY012S211**

L-T-P-C: 0-0-6-3 **Credit Units: 3** **Level: 100** **Scheme of Evaluation: P**

Objective: The **Basic preparative techniques in chemistry and food analysis** is to provide the practical knowledge of synthesis of inorganic and organic compounds as well as some basic techniques for determination the adulterants in food stuffs.

Course outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** the techniques that are useful in preparation of inorganic and organic compounds.	BT1
CO2	**Demonstrate** the synthetic methods for preparation of inorganic and organic compounds of practical importance.	BT2
CO3	**Make use** of the synthetic techniques to prepare different derivatives of simple organic molecules as well as coordination compounds.	BT3
CO4	**Demonstrate** different methods for finding the adulterants in food stuffs.	BT4

Detailed Syllabus:

12. Preparation of following inorganic compounds:
    c) Potassiumtrisoxalatoferrate(III) $K_3[Fe(C_2O4)_3].3H_2O$
    d) Potassiumtrisoxalatoaluminate(III) $K_3[Al(C_2O4)_3].3H_2O$
    e) Hexamminenickel(II) chloride, $[Ni(NH_3)_6]Cl_2$
    f) Hexammincobalt(II) chloride, $[Co(NH_3)_6]Cl_2$
2. Preparation of following organic compounds:
    a) Osazone from glucose.
    b) Aspirin from salicylic acid and acetic anhydride.
    c) Two step preparation:
        i) Aniline to acetanilide to p-nitroacetanilide

ii) Benzoin to benzil to benzilic acid.

3. To determine the adulterants in food stuffs:
   a) To detect adulterants in milk
   b) To detect adulterants in turmeric powder
   c) To detect vanaspati in pure ghee.

Text Books:

1. Vogel's Qualitative Inorganic Analysis; Svehla G. and Sivasankar B.; 7th edition; Pearson.

2. V*ogel's Textbook of Practical Organic Chemistry*, Vogel A.I., Aurther I., 5th edition; Pearson.

Reference Books:

1. Agarwal O. P.,*Advanced Practical Organic Chemistry*, 2nd Edition, 2014, Goel Publishing.

2. A text Book of Practical Chemistry, Barua, S, 2th edition; 2016; Kalyani Publisher

SYLLABUS (3rd SEMESTER)

Subject Name: Organic Chemistry I			**Subject Code: CHY012M301**
L-T-P-C – 4-0-0-4	**Level: 200**	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objective of **Organic Chemistry I** are to provide a thorough knowledge of stereochemistry and conformational analysis of organic molecules, classifications of reaction with mechanism, stability and reactivity of reaction intermediates.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** the stereo chemical and conformational aspect of molecules.	BT1
CO2	**Explain** the background of organic reaction mechanisms like formation of carbocation, carbenes etc and to know about the types of reactions and mechanisms by realizing the various factors which are affecting on the reactions.	BT2
CO3	**Apply** the concept of organic chemistry to understand the methods of preparation and chemical reactions of alkanes and cycloalkanes.	BT3
CO4	**Analyze** the reaction mechanism to develop strategy of a new	BT4

	reactions.	

Detailed Syllabus:

Modules	Topics & Course content	Periods
I	**Stereochemistry-I** Types of isomerism, types of stereoisomerism– conformational and configurational isomers, enantiomers & diastereomers. Geometrical isomerism– determination of configuration of geometrical isomers. Syn/anti, cis/trans & E/Z system ofnomenclature. Introduction to molecular symmetry and chirality, Axis, plane, centre, alternating axis of symmetry. Optical isomerism – optical activity, Criteria for showing optical activity, Enantiomers, stereogenic centre, asymmetry, molecular chirality, racemic modification, methods of resolution of racemic modification, Relative and absolute configuration; D, L and R, S configuration for asymmetric and dissymmetric molecules, Cahn-Ingold-Prelog rules. Conformational isomerism, conformation of acyclic systems with examples of ethane and butane, nomenclature for the conformers, projection formula-Newman projections and Sawhorse formulae, Fischer and flying wedge formulae, axial and equatorial bonds.	
II	**Organic reaction mechanism I** Idea of driving force, activation energy, transition state, energy profile diagrams, concept of kinetic and thermodynamic control of reactions, notations used in reaction mechanisms, types of bond fission, types of reagents – electrophiles and nucleophiles, types of reaction intermediates - carbocations, carbanions, free radicals, carbenes, arynes and nitrenes, methods of determination of reaction mechanism. Addition reactions: electrophilic, nucleophilic and free radical mechanism. Elimination reaction: ß-elimination reaction - base catalysed and pyrolytic elimination.	**12**

III	**Reaction mechanism II** Substitution reactions: Electrophilic, nucleophilic and free radical mechanism. Nucleophilic aliphatic substitution – SN1, SN2 reactions and free radical mechanism, energy profile diagram of SN1 and SN2 reactions and their stereochemistry, ambident nucleophiles and substrates. Mechanism of electrophilic aromatic substitution, directive influence of groups, activation and deactivation of aromatic rings, o/p ratio, mechanism to begiven with examples. Mechanism of nucleophilic aromatic substitution, intermediate complex mechanism, benzyne mechanism. Directive influences in benzyne mechanism, cine substitution, methods of trapping benzyne intermediates.	**12**
IV	**Chemistry of organic compounds – I** Alkanes –IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, methods of preparation of alkanes with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids, physical properties and chemical reaction of alkanes. Cycloalkanes – Baeyer's strain theory and its limitations, ring strain in small rings (cyclopropane and cyclobutane), theory of stainless rings, shapes of cyclopentane and cyclohexane rings,the case of cyclopropane ring: banana bonds.	**12**
	Total	**48**

Text books:

1. *Advanced organic chemistry: Reactions, mechanism and structure*; March Jerry; 7th edition; John Wiley; 2015; United States of America.
2. *Advanced organic chemistry*; Carey F. A. and Sundberg R. J.; 5th edition; 2007; Plenum.
3. *A guide book to mechanism in organic chemistry*; Sykes Peter; 6th edition; Longman.

Reference books:

1. Ingold C.K.; *Structure and mechanism in organic chemistry*; 2nd edition; Cornell University press.
2. Norman R.O.C.and Coxon J. M.; *Principle of Organic Synthesis*; 3rd edition; 1993; Blackie academic professional.
3. Warren S.; *Designing organic synthesis*; 2nd edition; 2008; Wiley; UK.
4. Nasipuri D.; *Stereochemistry of organic compounds*; 5th edition; 2014; New age international
5. Kalsi P.S.; *Stereochemistry of organic compounds*; 2007; New age international

SYLLABUS (3rd Semester)		
Subject Name: Chemistry Lab III	**Level: 200**	**Subject Code: CHY012M311**
L-T-P-C: 0-0-8-4	**Credit Units: 4**	**Scheme of Evaluation: P**

Objective: The objective of **Chemistry Lab-III** is to provide the knowledge of conductometric, pH metric and photophysical principles as well as practical experience of inorganic compound synthesis

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Show** the preparation of inorganic compounds	BT1
CO2	**Demonstrate** proficiency in the preparation of various inorganic compounds, understanding the principles of stoichiometry and chemical synthesis.	BT2
CO3	**Experiment** with titration techniques, encompassing conductometric titration and pH metric titrations	BT3
CO4	**To** apply fundamental principles of physical chemistry through experiments such as verifying Debye-Huckel, Onsagar equation, testing the validity of Beer-Lambert's law using a spectrophotometer, and determining the dissociation constant of acetic acid/oxalic acid using Henderson's equation	BT4

Detailed Syllabus:

1. Preparation of following Inorganic compounds:

a) Tetraamminecopper(II)sulfate, $[Cu(NH_3)_4]SO_4.H2O$

b) Potassiumtrioxalatochromate(III), $K_3[Cr(C_2O_4)_3].3H_2O$

c) Sodium trioxalatochromate (III), $Na_3[Fe(C_2O_4)_3].9H_2O$

2. Determination of acetic acid in commercial vinegar using NaOH.

3. To determine the percentage of calcium carbonate in precipitated chalk by using HCl and NaOH solution.

4. Conductometric titration
   i. HCl vs NaOH
   ii. Oxalic acid vs NaOH
   iii. Acetic acid vs NaOH.
5. To verify Debye, Huckel, Onsagar equation for sodium chloride.
6. To test the validity of Beer-Lambert's law using spectrophotometer.

7. pH metric titration of (i) strong acid with strong base, (ii) weak acid with strong base.
8. Determine the dissociation constant of acetic acid/ oxalic acid using Hendersen's equation.

Text Books:

1. Barua, S. (2016). *A Textbook of Practical Chemistry (2nd ed.).* Kalyani Publishers.
2. G. Svehla and B. Sivasankar. *Vogel's Qualitative Inorganic Analysis,* 7th edition; Pearson.

Reference Books:

1. Charles C. Garland, Joseph W. Nibler, and David P. Shoemaker. *Physical Chemistry: A Laboratory Manual.* 3rd edition (1996). McGraw-Hill Education.
2. John David Moynes and Robert J. Gordon. *Experimental Physical Chemistry: A Laboratory Textbook.* 2nd edition (1999), W. H. Freeman.
3. J Mendham, R.C. Denney, J.D. Barnes. and M.J.K. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th edition, 3rd Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
4. M Halpern, *Experimental Physical Chemistry*, 6th edition, 2014; Prentice Hall, Upper Saddle River, NJ 07458
5. Geoffrey Pass and Haydn Sutcliffe. *Practical Inorganic Chemistry.* 2nd edition, Blackie Academic & Professional
6. Judith K. Bassett. *Experimental Inorganic/Physical Chemistry: An Investigative, Integrated Approach To Practical Project Work*. 2nd edition, Oxford University Press.

SYLLABUS (3rd Semester) (Minor)		
Subject Name: Physical and Organic chemistry	**Level: 200**	**Subject Code: CHY012N301**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objectives of **Physical and Organic chemistry** is to provide the basic concepts of physical and organic chemistry. Nomenclature, methods of preparation and reactions of simple hydrocarbons will be taught in this paper along with basic concepts of stereochemistry. In physical chemistry, basic concepts of electrochemistry and chemical thermodynamics will be discussed.

Course outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** concept of isomerism, types of isomers and representation of organic molecules, Concept of geometrical isomerism with E/Z nomenclature.	BT1

CO2	**Demonstrate** concept of isomerism, types of isomers and representation of organic molecules. Concept of geometrical isomerism with E/Z nomenclature will also be discussed.	BT2
CO3	**Make use** of the basic concepts of electrochemistry.	BT3
CO4	**Learn** various basic concepts of thermodynamics.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Hours	Marks
I.	**Stereochemistry** Concept of isomerism, types of isomerism,classification – geometrical (simple examples involving alkenes, *cis-trans* and *E-Z* nomenclature) optical and conformational isomers, asymmetry, enantiomerism, diastereomerism, dissymmetry,meso structures, chirality, racemization, racemic mixtures, D-L and R-S notation.	**10**	**25**
II.	**Hydrocarbons I** Alkanes: preparation, properties and reactions. Cycloalkanes: preparation of cyclopropane, cyclobutane, cyclopentane, cyclohexane. Strain theory and stability. Alkenes: preparation (elimination of alkyl halides, alcohols, Wittig reaction, pyrolysis of esters), reactions of alkenes, Markownikoff's and anti- Markownikoff's addition rules, Saytzeff rule, Mechanism of electrophilic addition reaction. Alkynes: preparation, properties, reactions of alkynes, addition reactions of alkynes with polar reagents, ozonolysis, catalytic hydrogenation.	**10**	**25**
III.	**Electrochemistry** Electrochemical cells, electrode potential and cell potential (EMF), representation of a cell, electrochemical series and its application. Nernst's equation, numericals on electrode and cell potentials, reference electrodes (H_2 electrode, calomel electrode), glass electrode, concentration cell. Batteries: its classification, Lead – acid battery, Ni – Cd battery, alkaline battery, wind energy, fuel cell, solar cell.	**10**	**25**
IV.	**Chemical Thermodynamics** Terminology used in thermodynamics (system, surrounding, extensive and intensive properties),work, heat, energy and enthalpy, first law of thermodynamics and its limitations, reversible, adiabatic and isothermal expansion of an ideal gas, heat capacity and relation between C_p& C_v.	**10**	**25**

	Carnot theorem, entropy, entropy change for an ideal gas, reversible and irreversible processes, entropy of phase transitions,free energy and work function: Helmholtz and Gibbs free energy functions, Gibbs-Helmholtz equation, Clausius-Clapeyron equation, Gibbs-Duhem equation,chemical potential.		
	Total	**40**	**100**

Text Books:

1. *Organic Chemistry*, Morrison R. T. and BoydR.N., Bhattacharjee S.K.B.,6th edition, 2011, published by Prentice Hall.
2. *Organic Chemistry*, Solomons T.J.,11th Revised edition,2013, John Wiley & Sons Inc.
3. *Principles of Physical Chemistry*; Puri, B.R.; Sharma, L.R.; Pathania, M.S.; 47th edition; 2016; Vishal Publishing Company

Reference Books

1. Kapoor, K. L.; *A textbook of Physical chemistry*; 6th edition,; 2011; Macmillan, India
2. Kalsi P.S.; *Stereochemistry of organic compounds*;2007; New age international Ltd.

SYLLABUS (3rd Semester)

Subject Name: CEN III – Fundamentals of Business Communication **Subject Code: CEN982A301**

LTPC: 1-0-0-1 **Credit: 1** **Level: 200** **Scheme of Evaluation: T & P**

Course Objective: The aim of the course is to develop essential business communication skills, including effective writing, speaking, and interpersonal communication, to enhance professional interactions, collaboration, and successful communication strategies within diverse corporate environments.

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

CO Level	Course Outcome	Blooms Taxonomy Level
CO 1	**Define and list** business documents using appropriate formats and styles, demonstrating proficiency in written communication for various business contexts.	**BT 1**
CO 2	**Demonstrate** confident verbal communication skills through persuasive presentations, active listening, and clear articulation to engage and influence diverse stakeholders.	**BT 2**
CO 3	**Apply** effective interpersonal communication strategies, including conflict resolution and active teamwork, to foster positive relationships and contribute to successful organizational communication dynamics	**BT 3**

Detailed Syllabus		
Units	**Course Contents**	**Periods**
I	**Business Communication: Spoken and Written** • The Role of Business Communication • Classification and Purpose of Business Communication • The Importance of Communication in Management • Communication Training for Managers • Communication Structures in Organizations • Information to be Communicated at the Workplace • Writing Business Letters, Notice, Agenda and Minutes	**5**

II	**Negotiation Skills in Business Communication**
	• The Nature and Need for Negotiation
	  o Situations requiring and not requiring negotiations
	• Factors Affecting Negotiation
	  o Location, Timing, Subjective Factors
	• Stages in the Negotiation Process
	  o Preparation, Negotiation, Implementation
	• Negotiation Strategies
		5

III	**Ethics in Business Communication** • Ethical Communication • Values, Ethics and Communication • Ethical Dilemmas Facing Managers • A Strategic Approach to Business Ethics • Ethical Communication on the Internet • Ethics in Advertising	**5**
IV	**Business Etiquettes and Professionalism** • Introduction to Business Etiquette • Interview Etiquette • Social Etiquette • Workplace Etiquette • Netiquette	**5**

Text Books:

1. *Business Communication* by Shalini Verma
2. *Business Communication* by P.D. Chaturvedi and Mukesh Chaturvedi
3. *Technical Communication* by Meenakshi Raman and Sangeeta Sharma

SYLLABUS (3rd Semester)			
Subject Name: Behavioural Sciences -III			**Subject Code: BHS982A302**
LTPC: 1-0-0-1	**Credit: 1**	**Level: 200**	**Scheme of Evaluation: T**

Course objectives: To increase one's ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations .To enable the students to understand the process of problem solving and creative thinking.

Course outcomes: On completion of the course the students will be able to:

CO Level	Course Outcome	Blooms Taxonomy Level
CO1	Understand the process of problem solving and creative thinking.	**BT 1**
CO2	Develop and enhance of skills required for decision-making.	**BT 2**

Modules	Course Contents	Periods
I	**Problem Solving Process** Defining problem, the process of problem solving, Barriers to problem solving(Perception, Expression, Emotions, Intellect ,surrounding environment)	**4**
II	**Thinking as a tool for Problem Solving** What is thinking: The Mind/Brain/Behaviour Critical Thinking and Learning: -Making Predictions and Reasoning. -Memory and Critical Thinking. - Emotions and Critical Thinking.	**4**
III	**Creative Thinking** - Definition and meaning of creativity, - The nature of creative thinking :Convergent and Divergent thinking, - Idea generation and evaluation (Brain Storming) - Image generation and evaluation. - The six-phase model of Creative Thinking: ICEDIP model	**4**
IV	**Building Emotional Competence** Emotional Intelligence – Meaning, components, Importance and Relevance Positive and Negative emotions Healthy and Unhealthy expression of emotions	**4**
Total		**16**

Text books:

1. J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 3, Management; Pfeiffer &Company.
2. Blair J. Kolasa, Introduction to Behavioural Science for Business, John Wiley & Sons Inc.

SYLLABUS (3rd Semester)

Subject Name: Analytical Laboratory Methods Level: 200 **Subject Code: CHY012S311**

L-T-P-C: 0-0-6-3 **Credit Units: 3** **Scheme of Evaluation: P**

Objective:

The objectives of **Preparation and Estimation techniques** are to make students familiar with various methods of estimation, separation and preparation of derivatives.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**State** the importance of precipitation technique and its gravimetric analysis	BT1
CO2	**Explain** the concept of chromatography in separation of compounds.	BT2
CO3	**Prepare** important organic compounds and their derivatives.	BT3
CO4	**Analyse** and **Estimate** the organic components after separation.	BT4

1. **Gravimetric Analysis of two constituents**:
   I. To estimate copper and zinc in a given solution.
   II. To estimate iron and nickel in a given solution.
2. **Chromatographic separation of organic mixtures.**
   I. Separation of α –napthol and β-napthol by plate chromatography.
   II. Separation of anilines and phenols by plate chromatography.
3. **Separation of binary mixtures**
   I. Separation of a mixture of naphthalene and *p*-bromo benzoic acid (by $NaHCO_3$ solution)
   II. Separation of a mixture of anthracene and *p*-anisidine (by dil. HCl solution)
4. **Derivatives and their preparations**

I. Derivatives of aldehydes and ketones.
II. Derivatives phenolic hydroxyl group.
III. Derivatives of carbohydrates.

5. **Demonstration of UV-Vis Spectrophotometer**

Text Books:

1. *Advanced Practical organic Chemistry*, Agarwal, O. P.; 20th edition; 2014; Kalyani Publishers.
2. *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7th edition; Pearson.
3. *Advanced Practical Inorganic Chemistry*, Raj, G.; 22nd edition, 2019; Kalyani Publishers

Reference Books:

1. Mendham J., Denney R.C., Barnes J.D. and. Thomas M.J.K.; *Vogel's Textbook of Quantitative Chemical Analysis*, 6th edition, 3rd Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi
2. V*ogel's Textbook of Practical Organic Chemistry*, Vogel A.I., Aurther I., 5th Edition, 2005, Pearson.

SYLLABUS (4th SEMESTER)

Paper III/Subject Name: Inorganic Chemistry-I	**Subject Code: CHY012M401**
L-T-P-C – 4-0-0-4 **Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objective of **Inorganic Chemistry-I** is to make students familiar with advanced concept of chemical bonding as well as acid-base properties of inorganic compounds. It will also help students to understand the structures of common binary ionic crystals.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl. No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** the concepts of chemical bonding.	**BT1**
CO2	**Explain** the theories of transition elements.	**BT2**
CO3	**Apply** the concept of acid and base of inorganic compounds.	**BT3**
CO4	**Examine** the common binary ionic crystals to determine their structure	**BT4**

Detailed Syllabus:

Modules	Topics & Course content	Periods
I.	**Chemical Bonding II** Molecular orbitals of diatomic molecules: LCAO approximation, bonding, antibonding and nonbonding orbitals, MO configurations of simple homonuclear diatomic and hetero nuclear diatomic molecules, bond properties, bond order and bond strength. Weak chemical forces: van der Waals forces, ion- dipole forces, dipole-dipole interactions, induced dipole interactions, instantaneous dipole-induced dipole interactions. repulsive forces, hydrogen bonding, melting and boiling points, solubility energetics of dissolution process.	**13**
II.	**Chemistry of Non Transition Elements I** Polarizing power of cations, polarisability of anions, Fajan's rule, non-aqueous solvents: liquid ammonia, liquid sulphur dioxide, liquid HF, liquid N_2O_4 and supercritical CO_2. Preparation, properties, bonding and structure of the following: ortho and para hydrogen, hydrates, clathrates and inclusion compounds, binary metallic hydrides, allotropes of carbon (including fullerenes), graphite, intercalation compounds, carbides, cyanogens, oxides and oxy-acids of carbon.	**13**
III.	**Acid-Base Concept** Arrhenius concept, theory of solvent system (H_2O, NH_3, SO_2 and HF), Bronsted- Lowry's concept, relative strength of acids, Pauling rules, amphoterism, Lux- Flood concept, Lewis concept. superacid, HSAB principle. acid base equilibria in aqueous solution and pH, acid-base neutralisation curves, indicator, choice of indicators.	**13**
IV.	**Solids** Types of solids, unit cells; crystal lattices and Miller indices, crystal system and Bravais lattices for elemental crystals, close- packed structures of elemental solids, ionic solids: ionic radii; radius ratio and its effect on structures of binary ionic crystals. Structures of common binary ionic crystals: CsCl structure, NaCl structure, ZnS structure, fluorite structure, common ionic crystals: spinel and perovskite structures, lattice energy of ionic solids, Born-Haber cycle.	**13**
	Total	**52**

Text Books

1. *Concise Inorganic Chemistry*; Lee, J.D.; 5th edition; 2013; John Wiley and Sons Ltd.; Indian Edition.

2. *Inorganic Chemistry Principles of Structure and Reactivity*; Huheey, J.E., Keiter, E. A., Keiter, R. L. and Medhi, O. K. ; 4th edition; 2007; Pearson Education.

Reference Books:

1. *Inorganic Chemistry*; Atkins, P., Overtone, T., Rourke, J., Weller, M. and Armstrong, F.; 6th edition; 2014; Oxford University Press; Indian edition.

2. Cotton F.A., Wilkinson, G., Murillo A., Bochmann M.; *Advanced Inorganic Chemistry;*6th edition; 1999; Wiley Inters cience; New York.

SYLLABUS (4th Semester)

Subject Name: Physical Chemistry-I **Subject Code: CHY012M402**

L-T-P-C: 4-0-0-4 **Level: 200** **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The objective of **Physical Chemistry-I** is to learn the concepts of different states of matter, colligative properties of solutions and principles of electrochemistry and to apply it in different chemical reactions.

Course Outcomes:

After successful completion of the course, student will be able to

Sl No	Course Outcome	Bloom's Taxonomy Level
CO1	**Introduction** to gaseous state, thermodynamics involved and isotherms	BT1
CO2	**Acquire** knowledge about the structure of the liquid state and understand the physical properties of liquids, solutions, and their colligative properties.	BT2
CO3	**Demonstrate** knowledge about conductivity, equivalent and molar conductivity, Ostwald's dilution law and the dependence of molar conductivity on concentration and temperature.	BT3
CO4	**Explore** the effect of temperature on the rate of reaction, Arrhenius equation, and the concept of activation energy. Gain knowledge about consecutive, concurrent, and opposing reactions, as well as differential rate equations and steady-state approximation in reaction mechanisms	BT4

Detailed Syllabus:

Modules	Topics & Course Content	Periods
I	**Gaseous State** Postulates of kinetic theory of gases, derivation of the kinetic gas equation, Maxwell's distribution of molecular velocities, root mean square, average and most probable velocities, collision number, collision frequency, mean free path and collision diameter. *Behaviour of real gases:* Deviations from ideal gas behaviour, compressibility factor (Z),causes of deviation from ideal behaviour der Waals equation of state. *Critical phenomena:* P-V isotherm of real gases, principle of continuity of states, critical constants, relationship between critical constants and van der Waals constants, law of corresponding states.	**15**
II	**Liquid State, Solutions and Colligative Properties** Qualitative treatment of the structure of liquid state, physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination, effect of temperature on surface tension and viscosity. Dilute solutions, Raoult's law and Henry's law, definition of colligative properties: lowering of vapour pressure, elevation of boiling point, freezing point depression and osmotic pressure, thermodynamic treatment of colligative properties, abnormal colligative properties due to dissociation and association, van't Hoff factor, applications in calculating molar masses of normal, dissociated and associated solutes in solution.	**15**
III	**Electrolytic Conduction** Conductivity, equivalent and molar conductivity, dependence of molar conductivity on concentration and temperature, Kohlrausch's law of independent migration of ions, Debye-Hückel-Onsager equation, activity of ions, Debye Huckel theory (elementary ideas) of strong electrolytes Arrhenius theory of electrolytic dissociation, strong and weak electrolytes, degree of dissociation of weak acids and bases, Ostwald's dilution law, ionic product of water, solubility product of sparingly soluble salts, conductometric titrations, concept of pKa and pKb, buffer solution, derivation of Henderson equation, buffer action	**15**

IV	**Chemical Kinetics** Reaction rate, factors influencing the rate of a reaction, rate law, order and molecularity of a reaction, differential and integrated form of rate expressions for zero, first and second order reactions, half-life period, determination of the order of reaction by various methods, effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Consecutive, concurrent and opposing reactions, differential rate equations and steady-state approximation in reaction mechanisms, problems on steady-state approximation. Kinetics of chain reaction (Rice-Herzfeld mechanism), H_2-Br_2 reaction	**15**
	Total	**60**

Text Books:

1. Peter Atkins and Julio de Paula, *Physical Chemistry*, 11th edition (2017), Oxford University Press.
2. Puri, Sharma, and Pathania, *Principles of Physical Chemistry,* 47th edition, Vishal Publishing Co.
3. Donald A. McQuarrie and John D. Simon, *Physical Chemistry: A Molecular Approach*, 1st edition (1997), University Science Books.

Reference Books:

1. S Glasstone, *Text book of Physical Chemistry;* 11th edition; 2011; Van Nostrand company.
2. Gilbert W. Castellan. *Physical Chemistry*, (2004) Narosa.
3. Kapoor, K. L.; *A textbook of Physical chemistry*; 2018; Macmillan, India Ltd.
4. Bokris, J.A. and Reddy, A.K.N; *Modern Electrochemistry*; Vols. 1&2; Kluwer Academic Publishers
5. Keith J. Laidler, *Chemical Kinetics,*3e, (2003) Pearson Education India.

SYLLABUS (4th SEMESTER)

Paper III/Subject Name: Chemistry Laboratory-IV		**Subject Code: CHY012M413**
L-T-P-C – 0-0-8-4	**Credit Units: 4**	**Scheme of Evaluation: P**

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	Able to understand and analyse advanced experimental techniques in separation and determination of inorganic ions	BT1
CO2	Able to perform purification and qualitative analysis of organic liquid samples	BT2

CO3	Able to handle different instruments related to optical property in chemistry	BT3
CO4	Will get familiar with some modern instrumentation techniques.	BT4

1. Qualitative inorganic analysis (at least 4 sample containing mixtures of both acid and basic radicals): Identification of the following in an inorganic salt:
   Cations: Hg^{2+}, Pb^{2+}, Cu^{2+}, Bi^{3+}, As^{3+}, Sb^{3+}, Sn^{2+}/Sn^{4+}, Fe^{2+}/Fe^{3+}, Cr^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}

   Anions: Cl^{-}, Br^{-}, I^{-}, NO^{2-}, NO^{3-}, S^{2-}, $SO3^{2-}$
2. Determine the equivalent conductivity of acetic acid at infinite dilution by Kohlrausch's method and hence find out the degree of dissociation of the acid.
3. To determine the specific rotation of an optically active substance by polarometric method.
4. Qualitative analysis of organic liquid sample (Purification by fractional distillation, determination of boiling point, functional group analysis).

At least three samples should be done.

Text Book:

1. *Advanced Practical Physical Chemistry*; Yadav, J.B.; 28th edition; 2009; Goel Publishing House
2. *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7thedition; Pearson.
3. V*ogel's Textbook of Practical Organic Chemistry*, Vogel A.I., Aurther I., 5th Edition, 2005, Pearson.

Reference Books:

1. Gurtu, J.N., Gurtu, A.; *Advanced Physical Chemistry Experiments*, 6th edition, 2014, Pragati Prakashan
2. Halpern, M.; *Experimental Physical Chemistry*, 2nd edition, 1988; Prentice Hall, Upper Saddle River, NJ 07458
3. Agarwal O. P., *Advanced Practical Organic Chemistry*, 2nd Edition, 2014, Goel Publishing.

SYLLABUS (4th SEMESTER)

Subject Name: Organic and Inorganic Chemistry	**Level: 200**	**Subject Code:** CHY012N401
L-T-P-C: 3-0-0-3	**Credit Units: 3**	**Scheme of Evaluation: T**

Objective: The objective of **Organic and Inorganic Chemistry** is to provide basic understanding of important aromatic and aliphatic organic compounds as well as detailed discussions and applications on transition and non-transition elements.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Learn** the basic concepts of aromaticity of important organic compounds	BT1
CO2	**Study** the importance of coordination compounds and its magnetic behaviour	BT2
CO3	**Understand** allotropes of non-transition elements	BT3
CO4	**Classify** alcohols and carboxylic acids and study their reactions**.**	BT4

Detailed Syllabus:

Modules	Topics / Course content	Marks
I.	**Aromatic Hydrocarbons and Aromaticity** Definition and structure of aromatic compounds, structure of benzene, Resonance of benzene, Aromatic character: The Huckel 4n+2 rule, electrophilic aromatic substitution, effect of substituent groups. Polynuclear aromatic hydrocarbons and its reactions.	**25**
II.	**Hydrocarbon-II** Aliphatic and aromatic hydroxyl compounds: Classification of alcohols, 1°, 2° and 3° alcohols. General methods of preparation, properties and reactions Synthesis and reactions of phenols. Acidity of phenols. Electrophilic aromatic substitution of phenols. Aliphatic and aromatic carboxylic acids. General methods of preparation, properties and reactions of aliphatic and aromatic carboxylic acid.	**25**
III.	**Chemistry of non-transition elements** Allotropes of phosphorous. Hydrides, oxides and oxy-acids of phosphorous. Allotropes of sulphur, oxides, hydrides, oxyacids and per-acids of sulphur. Interhalogen compounds, polyhalides, pseudohalogen, oxides and oxyacids of halogens. Noble gas compounds – xenon oxides and fluorides.	**25**

IV.	**Coordination compounds** Types of ligands: monodentate, bidentate, ambidentate, polydentate and macro cyclic ligand. Nomenclature of complex compounds, Isomerism in 4- and 6-coordinate compounds, effective atomic number rule, valence bond, crystal field and introduction to ligand field theories, colour and magnetism	**25**
Total		**100**

Text Books:

1. "*Organic Chemistry*", Morrison R. T. and Boyd R.N., Bhattacharjee S.K.B., 6th edition, 2011, Prentice Hall.
2. "*Modern methods of organic synthesis"* Carruthers, W. and Coldham, I. 4th edition, 2015, Cambridge University Press.
3. "*Concise Inorganic Chemistry*", Lee J. D., 5th edition, 2008, John Wiley and Sons Ltd., Indian Edition.
4. *"Principles of Inorganic Chemistry"*, Puri B.R., Sharma L.R. and Kalia K.C.; 33rd edition, 2020, Vishal Publishing Co.

Reference Books:

1. Clayden, J., Greeves, N., and Warren, S. "*Organic chemistry*", 2nd edition, 2012, Oxford University Press, USA
2. Huheey J. E., Keiter E. A., Keiter R. L. and Medhi O. K., "*Inorganic Chemistry Principles of Structure and Reactivity*'',4th edition, 2006, Pearson Education.

SYLLABUS (4th Semester) (Minor)

Subject Name: General chemistry lab-II	**Level: 200**	**Subject Code: CHY012N412**
L-T-P-C: 0-0-6-3	**Credit Units: 3**	**Scheme of Evaluation: P**

Objective: The **General chemistry lab-II** is to provide the practical knowledge of basic practical chemistry like detection of hardness of water, preparation and use of TLC, synthesis of inorganic and organic compounds and some techniques for determination the adulterants in food items.

Course outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**

CO1	**Relate** the techniques that are useful in preparation of inorganic and organic compounds.	BT1
CO2	**Demonstrate** the synthetic methods for preparation of inorganic and organic compounds of practical importance.	BT2
CO3	**Make use** of the procedures required to estimate hardness of water.	BT3
CO4	**Demonstrate** different methods for finding the adulterants in stuffs and learn how to make TLC plates and use it for knowing fate of reaction.	BT4

Detailed Syllabus:

13. Preparation of following inorganic compounds:
    a) Ferrous ammonium sulfate or Mohr salt, $FeSO_4$. $(NH_4)_2SO_4.6H_2O$
    b) Chrome alum, $K_2SO_4.Cr_2(SO_4)_3.24H_2O$
2. Preparation of following organic compounds:
    a) Osazone from glucose.
    b) Benzil from benzoin.
3. To determine *any one* adulterants in food stuffs:
    a) To detect adulterants in milk
    b) To detect adulterants in turmeric powder
4. To determine the total hardness, calcium hardness and magnesium hardness of water.
5. To prepare TLC (Thin Layer chromatography) plates and gives spotting of reaction mixtures.

Text Books:

1. Vogel's Qualitative Inorganic Analysis; Svehla G. and Sivasankar B.; 7th edition; Pearson.

2. V*ogel's Textbook of Practical Organic Chemistry*, Vogel A.I., Aurther I., 5th edition; Pearson.

Reference Books:

1. Agarwal O. P.,*Advanced Practical Organic Chemistry*, 2nd Edition, 2014, Goel Publishing.
2. A text Book of Practical Chemistry, Barua, S, 2th edition; 2016; Kalyani Publisher

SYLLABUS (4th Semester)			
Subject Name: CEN IV: Business Communication: Concepts and Skills			**Subject Code: CEN982A401**
LTPC: 1-0-0-1	**Credit: 1**	**Level: 200**	**Scheme of Evaluation: T & P**

Course Objectives: This course is designed to enhance employability and maximize the students' potential by introducing them to the principles that determine personal and professional success, thereby helping them acquire the skills needed to apply these principles in their lives and careers.

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

CO Level	Course Outcome	Blooms Taxonomy Level
CO 2	**Demonstrate** understanding the importance of verbal and non-verbal skills while delivering an effective presentation.	**BT 2**
CO 3	**Develop** professional documents to meet the objectives of the workplace	**BT 3**
CO 3	**Identify** different life skills and internet competencies required in personal and professional life.	**BT 3**

Detailed Syllabus		
Units	**Course Contents**	**Periods**
I	**Presentation Skills** Importance of presentation skills, Essential characteristics of a good presentation, Stages of a presentation, Visual aids in presentation, Effective delivery of a presentation	**5**
II	**Business Writing** Report writing: Importance of reports, Types of reports, Format of reports, Structure of formal reports Proposal writing: Importance of proposal, Types of proposal, structure of formal proposals Technical articles: Types and structure	**5**
III	**Preparing for jobs** Employability and Unemployability, Bridging the Industry-Academia Gap Knowing the four- step employment process, writing resumes, Guidelines for a good resume, Writing cover letters Interviews: Types of interview, what does a job interview assess, strategies of success at interviews, participating in group discussions.	**5**

IV	**Digital Literacy and Life Skills** **Digital literacy:** Digital skills for the '21st century', College students and technology, information management using Webspace, Dropbox, directory, and folder renaming conventions. Social Media Technology and Safety, Web 2.0. **Life Skills**: Overview of Life Skills: Meaning and significance of life skills, Life skills identified by WHO: self-awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem-solving, Effective communication, interpersonal relationship, coping with stress, coping with emotion. Application of life skills: opening and operating bank accounts, applying for PAN, Passport, online bill payments, ticket booking, gas booking	**5**

Text Books:

1. *Business Communication* by Shalini Verma References:
2. *Technical Communication* by Meenakshi Raman and Sangeeta Sharma

Credit Distribution		
Lecture/Tutorial	**Practicum**	**Experiential Learning**
15 hours	-	10 hours - Movie/ Documentary screening - Field visits - Peer teaching - Seminars - Library visits

SYLLABUS (4th Semester)

Subject Name: Behavioural Sciences -IV **Subject Code: BHS982A402**

LTPC: 1-0-0-1 **Credit: 1** **Level: 200** **Scheme of Evaluation: T**

Course objectives: To increase one's ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations.

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

CO Level	Course Outcome	Blooms Taxonomy Level
CO1	Understand the importance of individual differences	**BT 2**
CO2	Develop a better understanding of self in relation to society and nation	**BT 3**
CO3	Facilitation for a meaningful existence and adjustment in society	**BT 3**

Modules	Course Contents	Periods
I	**Managing Personal Effectiveness** Setting goals to maintain focus, Dimensions of personal effectiveness (self disclosure, openness to feedback and perceptiveness), Integration of personal and organizational vision for effectiveness, A healthy balance of work and play, Defining Criticism: Types of Criticism, Destructive vs Constructive Criticism, Handling criticism and interruptions.	**4**
II	**Positive Personal Growth** Understanding & Developing positive emotions,Positive approach towards future, Impact of positive thinking, Importance of discipline and hard work, Integrity and accountability, Importance of ethics in achieving personal growth.	**4**
III	**Handling Diversity** Defining Diversity, Affirmation Action and Managing Diversity, Increasing Diversity in Work Force, Barriers and Challenges in Managing Diversity.	**4**
IV	**Developing Negotiation Skills** Meaning and Negotiation approaches (Traditional and Contemporary) Process and strategies of negotiations. Negotiation and interpersonal communication. Rapport Building – NLP.	**4**
Total		**16**

Text books:

1. J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 3, Management; Pfeiffer &Company
2. Blair J. Kolasa, Introduction to Behavioural Science for Business, John Wiley & Sons Inc.

SYLLABUS (5th SEMESTER)

Major (Core)/Subject Name: Organic Chemistry-II			**Subject Code: CHY012M501**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Level 300**	**Scheme of Evaluation: T**

Objective: The objective of **Organic Chemistry II** is to provide concept related to synthetic organic reactions and their mechanism along with information related to reagents used for reaction.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Understand** the concept involved in the reaction via analysis of reaction mechanism related to nucleophilic addition and substitution reaction on aromatic compounds.	BT1
CO2	**Explain** the mechanisms of various chemical reactions of alkyl halides, alcohols, alkenes and alkynes, carbonyl compounds, carboxylic acids and their derivatives, ether, amines and nitroalkanes.	BT2
CO3	**Apply** the reagents for the conversion of one functional group into other functional group in one or more number of steps.	BT3
CO4	**Analyze** the structures knowledge of commercially important molecules.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I.	**Chemistry of organic compounds – II** Alkyl halides–Methods of preparation and reactions, elimination vs. substitution reactions – controlling factors, mechanisms and stereochemistry of nucleophilic substitution reactions of alkyl halides. Alcohols – Preparation with special reference to reduction of aldehyde and ketones, hydroboration and oxymercuration, conversions to and from alcohols, hydrogen bonding, acidic nature and reaction of alcohol. Glycols and their reactions with lead tetra-acetate and periodic acid	**18**

II.	**Chemistry of organic compounds – III** Alkenes – Methods of preparation of alkenes, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, mechanism of elimination reactions: Saytzeff and Hoffmann elimination, properties of alkenes and relative stabilities of alkenes, mechanism involved in hydrogenation, electrophilic and free radical additions to alkenes , Markownikoff's rule, hydroboration-oxidation, epoxidation, ozonolysis, hydration, hydroxylation and oxidation with KMnO4, reactivities at the allylic and vinylic positions of alkenes. Alkynes – Methods of preparation of alkynes, chemical reactions of alkynes, acidity of alkynes, mechanism of electrophilic and nucleophilic addition reactions.	**18**
III	**Chemistry of organic compounds – IV** Carbonyl compounds: Preparation of carbonyl compounds. Nucleophilic addition to carbonyl compounds – redox reactions and condensation reactions. Mechanisms ofaldol condensation, Cannizzaro reaction, Claisen condensation, Reformatsky reaction,Oppeneauer reaction, Wolff-Kishner reduction, Benzoin condensation. Carboxylic acids and their derivatives: Preparation of carboxylic acids, acidity and effect of substituents. Derivatives of carboxylic acids – acid chlorides, amides and esters. Acidic and alkaline hydrolysis of esters.	**18**
IV	**Chemistry of organic compounds – V** Ethers: preparation, cleavage and auto-oxidation reactions. Epoxides: preparation, acid and base catalysed ring opening. Amines (aliphatic and aromatic): Classification and preparation of amines, distinction between primary, secondary and tertiary amines. Hoffmann bromamide reaction, exhaustive methylation and Hoffmann elimination, Hinsberg test, carbylamine test, Mannich reaction. Formation of diazonium salts, Sandmeyerreaction. Synthesis, and reactivity of nitroalkanes, alkyl nitriles, isonitriles and aromatic nitro compounds.	**18**
	Total	**72**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
72	**-----**	**48**

Text Books:

1. *Organic Chemistry*, Morrison R. T. and Boyd R.N., Bhattacharjee S.K.B., 6th edition, 2011, published by PrenticeHall.
2. *Organic Chemistry*,FinarI. L. 6th edition, (Low price), 2017, PearsonEducation.

Reference Books:

1. Peter Sykes, *A guide book to mechanisms in Organic Chemistry*, 6th edition, 2003, published by Pearson India.
2. KalsiP.S., *Organic Reactions and their Mechanisms*, 3nd dition, 2017, New Age International.
3. Organic Chemistry, Stanley H. Pine, 5th edition, 2010, McGraw-Hill Bool .
4. Organic Chemistry, Solomons T. J., 11th revised edition, 2013, John Wiley & Sons Inc.

SYLLABUS (5th SEMESTER)

Major (Core)/Subject Name: Inorganic chemistry II **Subject Code: CHY012M502**

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Level 300** **Scheme of Evaluation: T**

Objective: The objective of **Inorganic Chemistry-II** is to make students familiar with concept of coordination compounds as well as non-transition elements. It will also help students to understand the understand the biological role of inorganic elements.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl. No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** and get the detailed idea of structure and bonding of coordination compounds	BT1
CO2	**Explain** the concept of coordination chemistry to interpret their spectral and magnetic properties.	BT2
CO3	**Apply** the concept of bioinorganic chemistry to understand the biological role of elements.	BT3
CO4	**Examine** the chemistry of non-transition elements.	BT4

Detailed Syllabus:

Modules	Topics & Course content	Periods
I.	**Chemistry of coordination compounds I** EAN rule, structural and stereoisomers of complex compounds, IUPAC nomenclature of coordination compounds, Werner's theory, valence bond theory, crystal field theory, factors affecting 10 Dq value, crystal field stabilization energy, magnetic properties from crystal field theory, spectrochemical series, high spin and low spin complexes, Jahn-Teller distortion, structural and thermodynamic effects of orbital splitting, octahedral versus tetrahedral coordination.	**18**
II.	**Chemistry of Coordination Compounds II** Ligand field theory of octahedral complexes (without and with pi bonding), spectroscopic terms, R-S coupling, Mullikan's symbol, spectrochemical and naphelauxetic series, electronic spectra of simple Td and Oh complexes, selection rules and qualitative Orgel diagram (d^1 to d^9 system). Orbital and spin magnetic moments, spin-only magnetic moments of d^n ions in weak and strong crystal fields of Oh and Td symmetries, Orbital contribution and the effect of spin-orbit coupling, ferromagnetism and anti-ferromagnetism with examples from metal complexes.	**18**
III.	**Bioinorganic Chemistry** Elements of life: essential major, trace and ultratrace elements, importance of Na^+ and K^+ ions in biology, Na-K pump, biochemistry of Ca^{2+} ions, biological functions of hemoglobin and myoglobin, cytochromes and ferredoxins, carbonic anhydrase and carboxypeptidase. Biological nitrogen fixation, Pt and Au complexes as anticancer drugs, toxicity due to metal ions (Hg, Pb, Cd, As).	**18**
IV.	**Chemistry of Non Transition Elements II** Allotropes of phosphorous, hydrides, oxides and oxyacids of nitrogen and phosphorous, hydrazine, hydroxylamine and hydrogen azide, allotropes of sulphur, oxides, oxyacids and per-acids of sulphur, interhalogen compounds, polyhalides, pseudo halogen, oxides and oxyacids of halogens. Inorganic chains, ring and cages: silicate, aluminosilicates, zeolites, silicones, borazine, phosphazine, S_4N_4, P_4, P_4O_6, P_4O_{10}, diborane, boron cage compounds, carboranes and metallocarboranes.	**1**
	Total	**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
60 hrs	-	30 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books

1. *Concise Inorganic Chemistry*; Lee, J.D.; 5th edition; 2013; John Wiley and Sons Ltd.; Indian Edition.
2. *Inorganic Chemistry Principles of Structure and Reactivity*; Huheey, J.E., Keiter, E. A., Keiter, R. L. and Medhi, O. K. ; 4th edition; 2007; Pearson Education.

Reference Books

1. *Inorganic Chemistry*; Atkins, P., Overtone, T., Rourke, J., Weller, M. and Armstrong, F.; 6th edition; 2014; Oxford University Press; Indian edition.
2. Cotton F.A.,Wilkinson, G.,Murillo A., Bochmann M.;*Advanced Inorganic Chemistry;*6th edition; 1999; Wiley Interscience; New York.

SYLLABUS (5th SEMESTER)

Major (Core)/Subject Name: Physical Chemistry II **Subject Code: CHY012M503**

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Level 300** **Scheme of Evaluation: T**

Objective: The objective of **Physical Chemistry-II** is to learn the concepts of states of matter, colligative properties of solutions, and principles of electrochemistry and to apply it in chemical reactions.

Course Outcomes:

After successful completion of the course, the students will be able to		
Sl. No.	**Course Outcome**	**Bloom's Taxonomy Level**
CO 1	**Recall** the concepts of solid state, phase equilibria, electrochemistry and catalysis	**BT 1**
CO 2	**Explain** basic principles of crystallography, phase rule, chemical potential, catalysis and surface phenomenon.	**BT 2**
CO 3	**Apply** electrochemical series to explain reactivity of electrodes as well as apply Langmuir, Freundlich, BET equations to attainment of Adsorption isotherms	**BT 3**
CO 4	**Analyze** different crystallographic structures according to their co-ordination number and packing factors, and examine distillation process using phase diagram.	**BT 4**

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I	**Electrochemistry** Electrochemical cells: measurement of e.m.f. and electrode potentials, representation of a cell, electrochemical series and its application. concept of SHE, electrode-potential sign convention, different classes of electrodes, calomel electrodes and glass electrode and their applications, Nernst's equation, equilibrium constants and activity coefficients from standard electrode potentials, chemical cells and concentration cells, cells with and without transference, numerical on electrode and cell potentials. Batteries: its classification, zinc-graphite dry battery, Lead – acid battery, fuel cell.	**18**

	Electrochemical basis of corrosion in metals causes and effects, differential aeration corrosion, prevention of corrosion	
II	**Solid State** Laws of Crystallography, definition of unit cell and space lattice, Bravais lattices, Miller indices, Symmetry in solids, Bragg's law, Introduction to X-ray crystallography and determination of structure of solids. Packing in solid – octahedral hole, tetrahedral hole, radius ratio. Dislocation in solids – Schottky and Frenkel defects, Dielectric property of solids, Concept of piezo and ferro electricity, electrical property of solids (conductor, insulator, n type and p type semiconductors. Super conducting materials. Magnetic properties of solids (dia-, para-, ferro- and antiferro magnetism).	**18**
III	**Phase Equilibria** Definition of phase, meaning of components and degrees of freedom. Derivation of phase rule. Phase diagram of one component system (water). Phase diagram of two component system – eutectics, congruent and incongruent melting points, solid solutions. Interpretation of liquid-vapour, liquid-liquid and liquid-solid phase diagrams. Distillation of partially miscible liquids. Clausius Clapeyron equation for different phases. Systems of variable composition, partial molar quantities, Gibbs Duhem equation, Thermodynamics of mixing. Chemical potential, chemical potential of a component in an ideal mixture – fugacity, activity coefficients. Dependence of chemical potential on temperature and pressure.	**18**
IV	**Catalysis and Surface Chemistry** Definition, characteristics of catalyst, promoter and inhibitor, types of catalysis (homogeneous and heterogeneous), auto-catalytic reaction. Homogeneous catalysis: oxidation of SO2 to SO3 catalyzed by NO, acid-base catalysis, enzyme catalysis with Michaelis–Menten equation, turnover frequency, catalytic efficiency, effect of pH and temperature on enzyme catalysis, Heterogeneous catalysis: zeolites and their use as catalysts in cracking of petroleum. Introduction to solid surfaces, adsorption on surfaces – physisorption and chemisorption. Adsorption isotherms – Langmuir, Freundlich, BET equation. Determination of surface area, Catalytic activity at surface with examples	**18**
TOTAL		**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72	-----	48

Text Books:

1. *Physical Chemistry*, Atkins P. W. and Paula J. de; 10th edition; 2014; Oxford University Press
2. *Principles of Physical Chemistry*; Puri, B.R.; Sharma, L.R.; Pathania, M.S.; 47th edition; 2016; Vishal Publishing Company

Reference Books:

1. Glasstone, S.; *Text book of Physical Chemistry;* 11th edition; 2011; Van Nostrand company.
2. Atkins, P.W. and Paula, J. de; *Elements of Physical Chemistry;* 6th edition; 2018; Oxford University Press.
3. Kapoor, K. L.; *A textbook of Physical chemistry*; 6th edition; 2018; Macmillan, India Ltd.
4. Bokris, J.A. and Reddy, A.K.N; *Modern Electrochemistry*; Vols. 1&2; Kluwer Academic Publishers.

SYLLABUS (5th SEMESTER)			
Minor/Subject Name: Inorganic and Physical Chemistry			**Subject Code: CHY012N501**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Level: 300**	**Scheme of Evaluation: T**

Objective:

- To provide knowledge of organometallic chemistry and their use in catalytic processes.
- To provide the fundamental concepts of kinetic theory of gases, structure and some physical properties of liquids.
- To provide the concept of various types of catalysis, adsorption isotherms, and colloid stability.
- To provide the concept of crystal lattice, lattice defects and analyze the structure of some common ionic crystals.

Prerequisites:

- Concept of coordination chemistry, noble gas, ideal behavior of gases, catalysis, electromagnetic radiation, and idea of spectroscopy.
- Fundamentals of general chemistry from H.S. (10+1 and 10+2) level.

Course outcomes:

After successful completion of the course, student will be able to		
Sl. No.	**Course Outcome**	**Bloom's Taxonomy Level**
CO 1	**Define** 18 electron count, oxidative addition and reductive elimination reaction, adsorption isotherm, crystal defects.	BT 1
CO 2	**Demonstrate** kinetic theory of gases in predicting the behavior of gases, demonstrate the effect of temperature and pressure on enzyme catalysis.	BT 2
CO 3	**Apply** 18 electron in prediction coordinative unsaturation, **apply** adsorption isotherm to determine surface area of adsorbent.	BT 3
CO 4	**Categorize** types of carbonyl groups in metal carbonyls, **categories** various types of adsorption isotherm.	BT 4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I.	**Organometallic Compounds and Catalysis** Definition, electron count, 18 electron rule, isolobal analogy, structure and bonding in some organometallic compounds (Metal – Olefins compound, metal – ligand σ -bonded compounds, ferrocene, terminal and bridged carbonyls), oxidative addition and reductive elimination reaction. Uses of some organometallic compounds in catalysis (Wilkinson's catalyst, Vaska's compound and $HCo(CO)_4$).	**18**
II.	**Gaseous and Liquid State** Postulates of kinetic theory of gases – derivation of expression for pressure from kinetic theory, calculation of rms speed and average kinetic energy, deviation from ideal behavior, van der Waals equation of state. Structure of liquids, kinetic molecular model and properties of liquid, definition and experimental measurement of surface tension (drop number method) and viscosity (Ostwald method), variation of these properties with temperature.	**18**
III.	**Catalysis and surface chemistry** Homogeneous heterogeneous catalysis, acid-base catalysis catalytic promoter, poisoning, negative catalysis, enzyme catalysis, effect of temperature and pressure on enzyme catalysis, auto catalysis. Types of adsorptions. Differences between chemisorption and Physical adsorption; Freundlich adsorption isotherm and Langmuir adsorption isotherm, application of adsorption. Colloids-Classification, structure and stability.	**18**
IV.	**Solids** Crystal lattices, unit cells of the seven crystal systems. density of cubic unit cell, the fcc, bcc and simple cubic systems, closed packed structures, imperfections in solids, introduction to Schottky and Frenkel defects) Structures of common binary ionic crystals: CsCl structure, NaCl structure, ZnS structure.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
60	**-----**	**30**

Text Books:

1. "*Concise Inorganic Chemistry*", Lee J. D., 5th edition, 2008, John Wiley and Sons Ltd., Indian Edition.
2. "*Principles of Physical Chemistry*", Puri B. R., Sharma L. R., Pathania M. S., 47th edition, 2016; Vishal Publishing Company.

Reference Books:

1. Atkins, P. W.; and Paula, J. de., *"Physical Chemistry"*, 10th edition; 2011; Van Nostrand Company.
2. Huheey J. E., Keiter E. A., Keiter R. L. and Medhi O. K., "*Inorganic Chemistry Principles of Structure and Reactivity*'', 4th edition, 2006, Pearson Education.

Course Outcomes:

- The student is expected to gain the knowledge of organometallic chemistry and their applications.
- The students will understand the structure and properties of liquid.
- The student is expected to know the chemistry of catalytic processes.
- The student is expected to gain the concepts of crystal structure of solids.

SYLLABUS (6th SEMESTER)

Major (Core) / Subject Name: Spectroscopy			**Subject Code: CHY012M601**
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Level: 300**	**Scheme of Evaluation: T**

Objective: The objective of the course is to instill knowledge about the light matter interactions, principles of spectroscopic techniques and to give preliminary ideas about the applications of various spectroscopic techniques.

Course Outcomes:

After successful completion of the course, the students will be able to		
Sl. No.	**Course Outcome**	**Bloom's Taxonomy Level**
CO 1	**Define** and learn the electromagnetic radiation and basics of spectra.	BT 1
CO 2	**Explain** basic principles of Rotational, Vibrational and Raman Spectroscopy, Electronic Spectroscopy, Spin Resonance Spectroscopy and Mass Spectrometry.	BT 2
CO 3	**Integrate, compare** and **apply** various techniques in Structure Elucidation of molecules.	BT 3 & BT 4
CO 4	**Evaluate** the importance of Selection rules, chemical shift, Chromophore and McLafferty Rearrangement in spectroscopy.	BT4

Detailed Syllabus:

Modul es	Topics & Course Contents	Periods
I	**Basic theory of spectroscopy** Particle Nature of light, Electromagnetic Radiation, Spectral region, Interaction of electromagnetic radiation with matter, Energy Levels, Born Oppenheimer Approximation, Types of spectra-absorption and emission, Signal to Noise ratio, Spectral line width, Spectral Broadening-Collisional Broadening, Doppler Broadening, Intensity of Spectral Transitions- Factors affecting the intensity. Beer- Lambert Law, Molar Absorption coefficient, transmittance, absorbance	**18**
II	**Rotational, Vibrational and Raman Spectroscopy** Rotational Energy levels, Classification of molecules based on their moment of inertia, Rotational spectra of diatomic molecules - Rigid Rotator Concept, Selection rules, Intensities of Spectral Line, application of rotational spectra. Vibrational spectra of diatomic molecules – harmonic and anharmonic oscillators - Morse potential, Selection rules, calculation of force constants, dissociation energies, fundamental frequencies, overtones. Application IR spectra in structure elucidation- finger print region. Principle of Raman spectroscopy-Stokes and anti-Stokes lines, Classical Theory of Raman Spectra.	**18**
III	**Electronic Spectroscopy** Electronic transitions and selection rules, Electronic Transitions in diatomic molecule- selection rule - Vibrational fine structure, Types of electronic transitions, Franck-Condon principle, Nature of electronic states: singlet and triplet states, fluorescence and phosphorescence. Structure Elucidation- Chromophore, Auxochrome, absorption and intensity shifts, Woodward-Fieser rule for calculating absorption maxima (in conjugated diene system), Effect of solvents on electronic transition.	**18**
IV	**Nuclear Spin Resonance Spectroscopy and Mass Spectrometry** Principles of NMR spectroscopy, ^{1}H NMR Spectroscopy, presentation of the spectrum - chemical shift, chemical shift of simple organic molecules, spin-spin coupling and spectra of simple molecules. Mass Spectrometry: Principle, ionization techniques, fragmentation Pattern, nitrogen rule, McLafferty Rearrangement. Applications.	**18**

Total	72

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
72	**-----**	**48**

Text Books:

1. Fundamentals of Molecular Spectroscopy; Banwell Colin N., McCashEllain M; 4th edition; 2017; Tata McGraw-Hill.
2. Introduction to Spectroscopy; Pavia, D.L; Lampman; Kriz, G.S.; 5th edition, 2015; Brooks/Cole Cengage Learning.

Reference Books:

1. Modern Spectroscopy; Hollas, J.M; 4th edition, 2013, John Wiley & Sons
2. Organic Spectroscopy; Kemp, W.; 3rd edition, 2011; Palgrave

SYLLABUS (6th SEMESTER)

Major (Core)/Subject Name: Quantum Chemistry **Subject Code: CHY012M602**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Level: 300** **Scheme of Evaluation: T**

Objective: The basic objectives of this course are to impart quantum mechanical postulates in solving the Schrödinger equation and to apply LCAO-MO theory to real atoms/ions.

Course Outcomes:

After successful completion of the course, the students will be able to		
Sl. No.	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** the postulates and interpret the basic principles of quantum mechanics	BT1
CO2	**Apply** quantum mechanical treatment to various models	BT3
CO3	**Construct** atomic-orbital wave functions plot and **solve** spin-orbit interactions for Term symbols	BT3 & BT4
CO4	Evaluate the various orbital theories to **solve** for energy values of different molecules	BT 4

Detailed Syllabus:

Modules	Topics & Course Content	Periods
I	**Quantum Mechanics-I** Transition from classical mechanics to quantum mechanics: Black body radiation – Planck's hypothesis, Photoelectric effect – Einstein's explanation, Compton effect, Bohr's theory of atom: derivation for energy of an electron in hydrogen like species, de Broglie hypothesis, Heisenberg's uncertainty principle. Postulates of Quantum mechanics, wave functions, operators, eigen functions and eigen values, Schrodinger postulatesof operator transforms and the wave equation boundary conditions, normalization of the wave functions, expectation values,interpretation of the wave function – orthogonal and orthonormal wave functions.	18
II	**Quantum Mechanics-II** Model systems – particle in 1D and 3D boxes – particle in a ring, harmonic oscillator and rigid rotator (detailed mathematical treatment not necessary): Outline of solution of their Schrodinger equations, energy expression, wave functions and quantum numbers. Qualitative discussions of special features like degeneracy, energy level diagrams, plot of wave functions and their squares vs displacement from origin, zero point energy, quantum mechanical tunneling, force constant and bond strength (for harmonic oscillator), moment of inertia in 3D,angular momentum, space quantization of angular momentum (for rigid rotator).	18
III	**Atomic Structure** The Hamiltonian and Schrodinger equation for hydrogen and helium atoms, energy levels and quantum numbers, the radial and angular part of the wave functions, concept of atomic orbitals, plots of atomic-orbital wave functions and their squares vs. displacement from origin, construction of two-dimensional plots of probability density and calculation of radial probability functions, The orbitals of hydrogen and hydrogen-like atmos, contour diagrams of electron density, Stern- Gerlach experiment, electron spin and spin quantum number – spin orbitals, electron configuration of many electron atoms, Pauli's exclusion principle –illustration by He atom using wave functions, Spin-orbit interactions, Russel-Saunder's coupling, Term symbols. Effect of magnetic field on energy levels. Hund's rule.	18
IV	**The Nature of Chemical Bond** Schrodinger equation for a molecule, Born-Oppenheimer approximation, LCAO-MO theory as applied to $H_2^+$and H_2, drawback of MO theory. MO energy level diagram of homonuclear (O_2, N_2) and heteronuclear (HF, LiF, CO) diatomic molecules,HeitlerLondontheory – wave function and potential energy curve of H_2, concept of resonance and hybridisation from VB theory, term symbols of diatomic molecules. Huckel theory for ethene and benzene.	18
	Total	72

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
72	**-----**	**48**

Text Books:

1. *Quantum Chemistry*; Levine, I.N.; 7th edition, 2016; Prentice Hall of India
2. *Quantum Chemistry;* Prasad, R.K.; 4threvised edition; 2010; New Age International Publishers Limited

Reference Books:

1. Chandra, A.K.; I*ntroductory Quantum Chemistry*; 4threvised edition; 2017; Tata McGraw Hill
2. Sen, B.K.; Quantum Chemistry Including Spectroscopy; 4th edition; 2011; KakyaniPublisheres, New Delhi
3. McQuarrie, D.A.; *Quantum Chemistry*; 2nd edition; 2011; Viva Books Pvt Ltd
4. Atkins, P.W and S.F. Ronald; *Molecular Quantum Mechanics;* 5thedition; Oxford University Press.

SYLLABUS (6th SEMESTER)

Major (Core)/Subject: Introduction to Environmental & Green Chemistry **Subject Code: CHY012M603**

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Level: 300** **Scheme of Evaluation: T**

Objective: The objective of **Introduction to Environmental and Green Chemistry is** to provide the knowledge of major pollutants and different ways of treatment of air, water and soil pollutions. The students will be able to understand the fundamental concepts of green chemistry and to know its utility in modern synthesis.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl. No	**Course Outcome**	**Bloom's Taxonomy Level**
CO 1	**Define** the twelve principles of green chemistry and will build the basic understanding of toxicity, hazard, and risk of chemical substances.	BT 1

CO 2	**Summarize** the innovative approaches to solve the problems related to environmental and societal challenges.	BT 2
CO 3	**Build** the knowledge of green chemistry in problem solving skills, critical thinking and valuable skills to innovative and find out solution to environmental problems.	BT 3
CO 4	**Analyse** various chemical products and processes that are less toxic, than current alternatives.	BT 4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Atmospheric Chemistry** Composition of atmosphere – major regions of atmosphere**,** major air pollutants and their harmful effects. Depletion of ozone in the stratosphere, causes and remedial measures. The green-house effect and its consequences. Acid rain, photochemical smog, air pollution controls.	**18**
II	**Hydrosphere and Soil Chemistry** Criteria and standards of water quality- safe drinking water, water pollutants, wastewater treatment processes, water purification for drinking and industrial purposes. Composition of soil, types of soil, waste matters and pollutants in soil, waste classification, treatment and disposal, control measures of soil pollution.	**18**
III	**Introduction and principles of Green Chemistry** Introduction and definition of green chemistry, need and goal of green chemistry, limitations and obstacles of green chemistry, twelve principles of green chemistry with examples, prevention and minimization of generation of hazardous byproducts in chemical processes.	**18**
IV	**Green Chemistry synthesis** Designing of green synthesis using principles of green chemistry, selection of green solvents, basic idea of microwave and ultrasound assisted reactions, preliminary idea of solvent free reactions (solid phase reactions), biocatalysis in organic synthesis.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
72	**-----**	**48**

Text Book:

1. *Environmental Chemistry* De A. K.; 6th edition, New Age International, New Delhi.
2. *Environmental Chemistry*, Sharma B. K.; and Kaur, H., 2nd edition, **2013**, Goel Publishing House, Meerut.

Reference Books:

1. *Environmental pollution Control Engineering*, Rao C. S., 2nd edition, **2016**, New Age International.
2. *Green Chemistry: Environment Friendly alternatives*, Sanghi R. and Srivastava M. M., 2nd edition, 2018, Narosa Publishing House, New Delhi, India.
3. *Green Chemistry*, Ahluwalia V. K., 2nd edition, 2018, Narosa Publishing House, New Delhi.

SYLLABUS (6th SEMESTER)			
Major (Core)/Subject Name: Analytical Chemistry			**Subject Code: CHY012M604**
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Level: 300**	**Scheme of Evaluation: T**

Objective: The objective of **Analytical Chemistry** is to learn the importance of analytical data and basic concepts of separation and analysis of organic and inorganic materials.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** and represent analytical data obtained from analytical methods.	BT1
CO2	**Demonstrate** importance of purification and identification of analytes.	BT2
CO3	**Apply** the knowledge of analysis to understand the nature and properties of individual components.	BT3
CO4	**Categorize** and estimate and the chemical species present in the sample.	BT4

Detailed Syllabus:

Modules	Topics & Course Content	Periods
I	**Data analysis** Evaluation of analytical data: Accuracy and precision, deviation, relative mean deviation, standard deviation, variance, significant figures in reporting measurements and calculation. Types of errors: determinate and indeterminate errors, various types of determinate errors, absolute errors, relative errors.	18
II	**Conventional purification techniques and gravimetric analysis** Purification of solid organic compounds: extraction, use of immiscible solvents, solvent extraction, recrystallization. Purification of liquids: distillation, vacuum distillation, fractional distillation, azeotropic distillation – principles and techniques. Gravimetry: Introduction, precipitation, properties of precipitates, co-precipitation and post precipitation, drying and ignition, role of precipitating agents in gravimetric analysis.	18
III	**Chromatography** Introduction to chromatography, principle of chromatography, retention time, classification of chromatographic methods, paper chromatography, thin layer chromatography, R_f value, column chromatography, choice of solvent system in chromatography, ion-exchange chromatography, applications of chromatographic methods.	18
IV	**Titrimetric analysis** Redox titrations: theory and feasibility of redox titrations, redox indicators, their choice and application. Acid-Base Titrations: theory of neutralisation titrations, indicators-theory and choice of indicators for acid/base titrations, neutralization curves. Complexometric titration: theory, titrations involving monodentate and multidentate ligands (EDTA), metallochromic indicators and their choice.	18
Total		**72**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
72	**-----**	**48**

Text Books:

1. *Vogel's Qualitative Inorganic Analysis;* Svehla G. and Sivasankar B.; 7th edition; Pearson.
2. *Fundamental of Analytical Chemistry*, Skoog D.M.*;* 8th Edition, 2013; Saunders College Publishing, New York.

Reference Books:

2. Mendham J., Denney R.C., Barnes J.D. and. Thomas M.J.K.; *Vogel's Textbook of Quantitative Chemical Analysis*, 6th edition, 3rd Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
3. Day R.A. and A.L., *Quantitative Analysis;* Underwood, 9th edition, 2015 Prentice Hall, Inc. New Delhi.

SYLLABUS (6th SEMESTER)

Minor/Subject Name: Concepts of Analytical Chemistry **Subject Code: CHY012N601**

L-T-P-C – 4-0-0-4 **Credit Units: 4** **Level: 300** **Scheme of Evaluation: T**

Objective: The objective of **Concepts of Analytical Chemistry** is to provide the basic concept of chemical analysis through separation Techniques and titrimetric analysis. The students will also be able analyse the experimental data using data analysis knowledge.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** the importance of chemical analysis with instrumental techniques	BT1
CO2	**Explain** the concept of separation techniques and chromatographic techniques.	BT2
CO3	**Apply** titrimetric analysis in quantitative sample determination	BT3
CO4	**Analyze** the accuracy and types of errors in experimental data.	BT4

Detailed Syllabus:

Modules	Topics/ Course content	Periods
I	**Chemical analysis:** Introduction, stages of analysis, qualitative and quantitative analysis, importance of instrumental techniques, factors affecting the choice of analytical method.	15
II	**Separation Techniques:** Introduction, bulk separation, instrumental separation, filtration, solvent extraction, crystallisation and precipitation. Basic principles of chromatographic separation- Gas chromatography, liquid chromatography and thin layer chromatography.	15
III	**Titrimetric analysis:** Introduction, classification of reactions in titrimetric analysis, standard solution- primary and secondary standard. Principles of potentiometric titration, conductometric titration and complexometric titration.	15
IV	**Errors and accuracy**: Definition of Significant figures, accuracy and precision, mean, median, variance, deviation, relative mean deviation, standard deviation. Error-Determinate and indeterminate error, absolute errors, relative errors.	15
Total		60

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
60	**-----**	**30**

Text Books:

1. *Fundamentals of Analytical Chemistry,* Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Cengage Learning, **2013**
2. *Vogel's Quantitative Chemical Analysis,* J Mendham, R C Denney, J D Barnes and M J K Thomas, 6th Edition, **2009**

Reference Books:

1. *Analytical Chemistry,* Gary D. Christian, 6ed Paperback – **2007**

SYLLABUS (7th SEMESTER)

Major(Core)/Subject Name: Organic Chemistry-III		Subject Code: **CHY012M701**
L-T-P-C: 4-0-0-4	**Credit Units: 4 Level: 400**	**Scheme of Evaluation: T**

Objective: The objective of **Organic Chemistry III** is to provide concept related to synthetic organic reactions, rearrangement, and their mechanism along with information related to pericyclic and photochemical reactions.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Understand** the concept behind mechanism of molecular rearrangements, pericyclic reactions and photochemical reactions.	BT1
CO2	**Explain** with mechanisms, the chemical reactions of Phenols, haloarenes, polynuclear hydrocarbons, active methylene compounds and heterocyclic compounds	BT2
CO3	**Apply** basic concept of molecular rearrangements to synthesize important molecules from starting materials.	BT3
CO4	**Analyze** the structures of compounds formed by various rearrangements.	BT4

Detailed Syllabus:

Modules	**Topics / Course content**	**Periods**
I.	**Chemistry of organic compounds – VI** Phenols: Preparation and typical reactions, Kolbe's reaction, Reimer-Tiemann reaction. Haloarenes: Preparation, mechanism of nucleophilic aromatic substitution, benzyne mechanism, cine substitution, chichibabin reaction and methods of trapping benzyne intermediates. Polynuclear aromatic hydrocarbons: Structure, bonding, properties and reactivity of naphthalene, anthracene, phenanthrene and anthraquinone-important methods of synthesis.	**18**

II.	**Chemistry of organic compounds – VII** Active methylene compounds: The active methylene group, synthesis of compounds containing active methylene groups (ethyl acetoacetate, diethylmalonate and ethyl cyanoacetate) and their use in organic synthesis. Heterocyclic compounds: Synthesis, structure, bonding, properties (basicity, aromaticity) and reactions of the following heterocycles: Furan, pyrrole, indole, thiophene, pyridine, quinoline and isoquinoline.	**18**
III	**Molecular Rearrangements** 1. Nucleophilic or anionotropic: Wagner-Meerwein rearrangement, Whitmore 1, 2-shift, Wolff, Curtius, Hoffmann, Lossen, Schmidt, Favorskii, Beckmann, Benzil-benzilic acid, Baeyer–Villiger rearrangements. 2. Electrophilic or cationotropic: pinacol rearrangement. 3. Free radical: Wittig rearrangement. Special rearrangements: Fries rearrangement, Stevens rearrangement.	**18**
IV	**Pericyclic Reactions and Organic Photochemistry** Definition and examples of 2+2 and 2+4 cycloadditions. The conservation of orbital symmetry. Woodward Hoffman rules. Diels Alder reaction, 1, 3 Dipolar Cycloaddition. Sigmatropic rearrangements-Cope and Claisen rearrangements. Electrocyclic reactions. Basic principles, Jablonski diagram, Typical photochemical reactions: Photo-reduction of benzophenone, photolysis of ketones, Norrish type-I and Norrish type-II reactions, dimerization and cycloaddition of ethene.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	**-**	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

***Text Books*:**

1. *Organic Chemistry*, Morrison R. T. and Boyd R.N., Bhattacharjee S.K.B., 6th edition, 2011, published by Prentice Hall.

2. *Organic Chemistry*, Inari. L. 6th edition, (Low price), 2017, Pearson Education.

3. Advanced Organic Chemistry, by B S Bahl and Arun Bahl.

Reference Books:

1. Peter Sykes, *A guide book to mechanisms in Organic Chemistry*, 6th edition, 2003, published by Pearson India.
2. Kalsi P.S., *Organic Reactions and their Mechanisms*, 3nd edition, 2017, New Age International.
3. Organic Chemistry, Stanley H. Pine, 5th edition, 2010, McGraw-Hill Bool .

4. Organic Chemistry, Solomons T. J., 11th revised edition, 2013, John Wiley & Sons Inc.

SYLLABUS (7th SEMESTER)

Major(Core)/Subject Name: Physical Chemistry III			Subject Code: CHY012M702
L-T-P-C – 4-0-0-4	Credit Units: 4	Level: 400	Scheme of Evaluation: (T)

Objective: The objective of **Physical Chemistry-II** is to learn the concepts of different states of matter, colligative properties of solutions, and principles of electrochemistry and to apply it in different chemical reactions.

Course Outcomes:

After successful completion of the course, the students will be able to		
Sl. No.	**Course Outcome**	**Bloom's Taxonomy Level**
CO 1	**Relate** the ideal and non- ideal behaviors of (real) gas, critical phenomena of gases, solutions properties and electrolytic conduction.	**BT 1**
CO 2	**Explain** the properties of liquid and conductivity of strong and weak electrolytes.	**BT 2**
CO 3	**Apply** the concept of colligative properties to determine the molar mass of solutes.	**BT 3**
CO 4	**Evaluate** the critical phenomena of gases, buffer action, pKa and pKb, buffer solution	**BT 4**

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I	**Gaseous State** Postulates of kinetic theory of gases, derivation of the kinetic gas equation, Maxwell's distribution of molecular velocities, root mean square, average and most probable velocities, collision number, collision frequency, mean free path and collision diameter. Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor (Z), causes of deviation from ideal behaviour der Waals equation of state.	**18**

	Critical phenomena: P-V isotherm of real gases, principle of continuity of states, critical constants, relationship between critical constants and van der Waals constants, law of corresponding states.	
II	**Liquid State** Qualitative treatment of the structure of liquid state, physical properties of liquids; vapor pressure, surface tension and coefficient of viscosity, and their determination, effect of temperature on surface tension and viscosity, explanation of cleansing action of detergents. Liquid crystals: An introduction to liquid crystals, classification and properties of liquid crystals.	**18**
III	**Solutions and Colligative Properties** Dilute solutions, Raoult's law and Henry's law, definition of colligative properties: lowering of vapor pressure, elevation of boiling point, freezing point depression and osmotic pressure, thermodynamic treatment of colligative properties, abnormal colligative properties due to dissociation and association, van't Hoff factor, applications in calculating molar masses of normal, dissociated and associated solutes in solution.	**18**
IV	**Electrolytic Conduction** Conductivity, equivalent and molar conductivity, dependence of molar conductivity on concentration and temperature, Kohlrausch's law of independent migration of ions, Debye-Hückel-Onsager equation, activity of ions, Debye-Hückel theory (elementary ideas) of strong electrolytes, transport number of ions and its determination. Arrhenius theory of electrolytic dissociation, strong and weak electrolytes, degree of dissociation of weak acids and bases, Ostwald's dilution law, ionic product of water, solubility product of sparingly soluble salts, conductometric titrations, concept of pKa and pK_b, buffer solution, derivation of Henderson equation, buffer action.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72	-----	48

***Text Books*:**

1. *Physical Chemistry*, Atkins P. W. and Paula J. de; 10th edition; 2014; Oxford University Press
2. *Principles of Physical Chemistry*; Puri, B.R.; Sharma, L.R.; Pathania, M.S.; 47th edition; 2016; Vishal Publishing Company

Reference Books:

1. Glasstone, S.; *Text book of Physical Chemistry;* 11th edition; 2011; Van Nostrand company.
2. Atkins, P.W. and Paula, J. de; *Elements of Physical Chemistry;* 6th edition; 2018; Oxford University Press.
3. Kapoor, K. L.; *A textbook of Physical chemistry*; 6th edition; 2018; Macmillan, India Ltd.
4. Bokris, J.A. and Reddy, A.K.N; *Modern Electrochemistry*; Vols. 1&2; Kluwer Academic Publishers

SYLLABUS (7th SEMESTER)

Major(Core)/Subject Name: Inorganic Chemistry-III	**Subject Code: CHY012M703**
L-T-P-C – 4-0-0-4 **Credit Units: 4** **Level 400**	**Scheme of Evaluation: T**

Objective: The objective of **Inorganic Chemistry-III** is to make students familiar with advanced concept of organometallic chemistry as well as inorganic reaction mechanism. It will also help students to understand the chemistry of d & f block elements and radioactive elements.

Course Outcomes:

After successful completion of the course, student will be able to

Sl. No	Course Outcome	Bloom's Taxonomy Level
CO1	**Define** organometallic compounds and apply the knowledge to know their bonding and applications.	BT1
CO2	**Explain** the theories of transition elements (d and f block)	BT2
CO3	**Apply** the concept of **inorganic reaction mechanism to understand inorganic reactions.**	BT3
CO4	**Illustrate** the concept of nuclear chemistry to understand various types of nuclear reactions as well as application of radioactive elements.	BT4

Detailed Syllabus:

Modules	Topics & Course content	Periods
	Organometallic Compounds 18-electron rule and its applications, carbonyls: preparation, structure and reactions, metal-olefin complexes: Zeises salt (preparation, structure and bonding), Ferrocene (preparation, structure and reactions), hapticity(η) of	

I.	organometallic ligands, Coordinative unsaturation: oxidative addition, reductive elimination and insertion reactions. Homogeneous catalysis by organometallic compounds: hydrogenation, hydroformylation and polymerization of alkenes (Ziegler-Natta catalysis).	**18**
II.	**Chemistry of d- and f- block elements** **d-block elements**: General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. **f-block elements**: electronic configuration, ionization energies, oxidation states, variation in atomic and ionic (3+) radii, lanthanide contraction, magnetic properties of lanthanides comparison between lanthanide and actinides, separation of lanthanides.	**18**
III.	**Inorganic reaction mechanism & symmetry** Introduction to inorganic reaction mechanism, inert and labile complexes, association, dissociation and concerted paths, acid and base hydrolysis (with reference to cobalt complexes only), substitution reaction in octahedral and square planar complexes, trans effect, electron transfer reactions- outer and inner sphere mechanism Symmetry elements and symmetry operations, definition of point groups, point groups of simple molecules, symmetry of octahedron, tetrahedron and square planar complexes, structure and symmetry of simple inorganic compounds.	**18**
IV.	**Nuclear Chemistry** Physical properties of the proton and the neutron, structure of the nucleus, mass defect and binding energy. Radioactive decay and equilibrium. Nuclear reactions, Q value, nuclear cross sections. Theory of radioactive disintegration, rates of disintegration, the radiochemical series. Transmutation of elements and artificial radioactivity, fission and fusion. Nuclear reactions and their use, methods of measurement of radioactivity. Isotopes of elements, methods of separation of isotopes, application of isotopes (tracer technique, neutron activation analysis, radiocarbon dating).	**18**
	Total	**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	-	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books

1. *Concise Inorganic Chemistry*; Lee, J.D.; 5th edition; 2013; John Wiley and Sons Ltd.; Indian Edition.
2. *2. Inorganic Chemistry Principles of Structure and Reactivity*; Huheey, J.E., Keiter, E. A., Keiter, R. L and Medhi, O. K.; 4th edition; 2007; Pearson Education.

Reference Books

1. *Inorganic Chemistry*; Atkins, P., Overtone, T., Rourke, J., Weller, M. and Armstrong, F.; 6th edition; 2014; Oxford University Press; Indian edition.
2. Cotton F.A.,Wilkinson, G.,Murillo A., Bochmann M.;*Advanced Inorganic Chemistry;*6th edition; 1999; Wiley Interscience; New York.

SYLLABUS (7th SEMESTER)

Major(Core)/Subject Name: Name Reactions and Reagents in Organic Chemistry **Subject Code: CHY012M704**

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Level: 400** **Scheme of Evaluation: T**

Objective: The objective of **Name reactions and reagents in organic chemistry** is to provide concept related to reagents and reactions involved in synthetic organic reactions.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Understand** the concept involved in various name reactions.	BT1
CO2	**Explain** the mechanisms involved in various name reactions.	BT2
CO3	**Apply** the reagents for the conversion of one functional group into other functional group in one or more number of steps.	BT3
CO4	**Analyze** the role of organic reagents in various organic transformations.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I.	**Selective Name Reactions-I** Aldol condensation, Perkin reaction, Stobbe reaction, Dieckmann condensation, Diels-Ader reactions, Robinson annulation, Michael reaction, Mannich, Stork enamine, Sharpless asymmetric epoxidation, Barton, Ene, Suzuki reaction, Heck reaction, Buckwald reaction.	**18**
II.	**Selective Name Reactions-II** Hoffman-Loffler- Freytag, Shapiro reaction, Chichibabin, Cannizaro, Bayer-Hilman, Darens, Benzoin condensation, Knoevenegel, Reimer-Tieman reaction, Wolf- Kishner reduction, Clemmenson reduction, Moningo reduction, Meerwein-Pondorf-Verley reduction, Oppenauer oxidation, Dess-Martin oxidation, Swern oxidation, Reformatsky reaction.	**18**
III	**Reagents in organic synthesis-I** Complex metal hydrides, DIBAL-H, Gilman's reagent, LDA, DCC, 1,3-propane dithiane, Trimethyl-silyl-tin hydride, Tri-n-butyl-tin hydride, Woodwords and Prevost hydroxylation, DDQ, SeO_2, Methods of generation, properties and reactions of organo magnesium, lithium, cadmium, copper, Grignard reagent and its application,	**18**
IV	**Reagents in organic synthesis-II** PPC, PDC, Merifield resins, Peterson's synthesis, Baker's yeast, Chromic acid, Potassium dichromate, Jones reagent, Collins reagent, Birch reduction, Periodic acid, Lead tetra acetate, Osmium tetra oxide, Ozonolysis, m-CPBA, Wittig reagent, Phosphorous and sulfur ylides: methods of generation, properties and reactions.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	-	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. Advanced organic chemistry: Reactions, mechanism and structure; March Jerry; 7th edition; John Wiley.
2. *Organic Chemistry*, Finar I. L. 6th edition, (Low price), 2017, Pearson Education.

Reference Books:

1. Peter Sykes, *A guidebook to mechanisms in Organic Chemistry*, 6th edition, 2003, published by Pearson India.
2. Kalsi P.S.,*Organic Reactions and their Mechanisms*, 3nd edition, 2017, New Age International.
3. Organic Chemistry, Stanley H. Pine, 5th edition, 2010, McGraw-Hill Bool.
4. Organic Chemistry, Solomons T. J., 11th revised edition, 2013, John Wiley & Sons Inc.

SYLLABUS (7th SEMESTER)

Minor/Subject Name: Chemistry in Everyday Life			**Subject: CHY012N701**
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Level: 400**	**Scheme of Evaluation: T**

Objective:
The objective of **Chemistry in everyday life** is to enhance understanding of materials and their effects on the environment.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Find** the concepts of chemistry related to drugs, colloids and corrosion.	BT1
CO2	**Summarize** the knowledge on awareness on handling chemicals.	BT2
CO3	**Apply** the concepts of chemistry to solve the problems in day to day life.	BT3
CO4	**Analyze** the influence of chemistry in day to day life.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I.	**Colloids and Cleansing Agents**: Classification, preparation methods – Dispersion and Condensation, application of colloids. Detergents and its classification, Advantage and disadvantage of soap.	**18**
II.	**Corrosion:** Introduction, corrosion types – dry and wet corrosion, mechanism of corrosion, pitting, stress, intergranular and waterline corrosion, factors influencing corrosion, corrosion failure, corrosion control.	**18**
	Toxic chemicals in the environment: Detergents - pollution aspects, eutrophication. Impact of pesticides and insecticides. Heavy metal	**18**

III.	pollution. Solid pollutants - treatment and disposal. Treatment of industrial liquid wastes. Sewage and industrial effluent treatment.	
IV.	**Chemistry of Drugs:** Introduction of Drugs, antacid, Tranquilizers (Psychotherapeutic Drugs), neurotransmitter, analgesics- narcotics and non-narcotics, antipyretics, anti-microbial	**18**
Total		

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	**-**	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Textbooks

1. Drugs and Pharmaceutical Sciences Series, Marcel Dekker, Vol.II, INC, New York.

2. Analysis of Foods – H.E. Cox; 13. Chemical Analysis of Foods- H.E. Cox and Pearson.

Reference Books*:*

1. B.K. Sharma: introduction to Industrial Chemistry, Goel Publishing, Meerut(2018)

2. Handbook on Fertilizer Technology by Swaminathan and Goswamy, 6 th ed. 2016, FAI.

3. Foods – Facts and Principles. N. Shakuntala Many and S. Swamy, 4th ed. New Age Internatl (2018).

SYLLABUS (8th SEMESTER)

Major (Core)/Subject Name: Advanced Instrumental Techniques			**Subject Code: CHY012M801**
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Level 400**	**Scheme of Evaluation: (T)**

Objective: The objective of **Advanced Instrumental Techniques** is to introduce fundamental concepts of advanced instruments commonly used in chemical analysis. Students will gain an understanding of instrument calibration and learn to analyze experimental data using data analysis techniques, with applications in molecular analysis.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Relate** the importance of several instrumental techniques	BT1
CO2	**Explain** the working principles of different instruments	BT2
CO3	**Apply** the knowledge of the instrumental techniques to analyse unknown samples	BT3
CO4	**Analyze** the experimental data obtained from the instruments for structure elucidation.	BT4

Detailed Syllabus:

Modules	Topics/ Course content	Period
I	**Nuclear Magnetic Resonance spectroscopy:** Principles of H-NMR and C-NMR, chemical shift, factors affecting chemical shift, coupling constant, Spin – spin coupling, relaxation, instrumentation and applications **Mass Spectrometry:** Principles, Fragmentation, Ionization techniques, chemical ionization, MALDI, FAB, Analyzers-Time of flight and Quadrupole, instrumentation, applications **Hyphenated techniques:** LC-MS/MS, GC-MS/MS, HPTLC-MS.	**18**
II	**Thermal Methods of Analysis:** Principles, instrumentation and applications of Thermogravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC)	**18**

	X-Ray Diffraction Methods: Origin of X-rays, basic aspects of crystals, X-ray Crystallography, rotating crystal technique, single crystal diffraction, powder diffraction, structural elucidation and applications.	
III	**Calibration and validation**-as per ICH and USFDA guidelines. **Calibration of following Instruments:** Electronic balance, UV-Visible spectrophotometer, IR spectrophotometer, Fluorimeter, Flame Photometer, HPLC and GC.	**18**
IV	**Infra-Red Spectroscopy:** Principles of FT-IR, IR Spectrophotometer, different IR regions- Near IR, far IR and fingerprint region, Common IR peaks for Functional group determination, Limitation and Applications of FT-IR. **FT-IR sample preparation:** Different methods – Liquids, solids (in solution), solids (as Nujol mulls), KBr pellets/disks, thin film.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	**Practicum**	**Experimental Learning**
72	**-----**	**48**

Text Books:

1. *Instrumental Methods of Chemical Analysis*, B.K Sharma, 24th Edition, **2005.**
2. *Organic spectroscopy*, Y.R Sharma, **2007**.
3. *Organic spectroscopy,* William Kemp, 1st Edition.
4. *Spectroscopy of organic compounds,* P.S. Kalsi*,* 9th Edition, **2022**.

Reference Books:

1. *Spectrophotometric identification of Organic Compounds,* Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce, 8th Edition, **2014.**

Subject Name: Research Methodology			**Subject Code: CHY012N801**
L-T-P-C: 4-0-0-4	**Credit Units: 4**	**Level=400**	**Scheme of Evaluation: T**

Objective: The objectives of **Research Methodology** is to impart knowledge about the basic concepts of research and to provide a road map for conducting research. Students are expected to identify, explain and apply basic concepts of research; acquire information, recognize various issues related to research and to learn instrumental methods required for research in chemistry.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** the terms related to Research.	BT1
CO2	**Understand** about safe storage of chemicals, disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals.	BT2
CO3	**Apply** research methods, paper and report writing, and tools to conduct research.	BT3
CO4	**Examine/Analyse** the research work.	BT4

Prerequisites:

- Knowledge about chemistry related software and online scientific databases like Google Scholar, SciFinder, Scopus etc.
- Basic knowledge of MS-Word
- Basic knowledge of MS-Excel

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Literature Survey:** Print: Sources of information-Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples. Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-Databases, ChemSpider, Science Direct, SciFinder, Scopus.	**18**
II	**Resources and Writing Scientific Papers**: Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information. Methods of Scientific Research and Writing Scientific Papers:	**18**

	Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation. Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.	
III	**Chemical Safety and Ethical Handling of Chemicals** Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	**18**
IV	**Data Analysis** The Investigative Approach: Making and recording measurements. SI units and their use. Scientific method and design of experiments. Analysis and presentation of data: Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, general polynomial fitting, linearizing transformations, exponential function fit, r and its abuse. Basic aspects of multiple linear regression analysis.	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	As a part of the tutorial class students are expected to: 1. Acquaint themselves with chemistry related software and online scientific databases like Google Scholar, SciFinder, Scopus etc. 2. Undertake hands-on-sessions to identify research misconduct and predatory publications. 3. Acquaint the students with Indexing and citation databases, open access publications, research metrics (citations, h-index, Impact Factor, etc.) and plagiarism tools.

Reference Books:

1. Kothari, C. K.; Garg, G. Research Methodology-Methods and Techniques, 3rd Ed., New Age International, New Delhi (2014).
2. Kumar, R. Research Methodology–A Step-By-Step Guide for Beginners; 2nd Ed., Pearson Education: New Delhi (2005).

3. Montgomery, D. C. Design & Analysis of Experiments; 8th Ed., Wiley India: Noida (2013).
4. Dean, J. R.; Jones, A. M.; Holmes, D.; Reed, R.; Weyers, J.; Jones, A. Practical Skills in Chemistry, 2nd Ed. Prentice-Hall, Harlow (2011).
5. Hibbert, D. B.; Gooding, J. J., Data Analysis for Chemistry. Oxford University Press (2006).
6. Topping, J., Errors of Observation and their Treatment, 4th Ed., Chapman Hall, London (1984).
7. Harris, D. C., Quantitative Chemical Analysis, 6th Ed., Freeman (2007) Chapters 3-5.

SYLLABUS (8th SEMESTER)

Advanced Course/Subject Name: Industrial and Polymer Chemistry	**Subject Code: CHY012M802**
L-T-P-C – 4-0-0-4 **Credit Units: 4** **Level 400**	**Scheme of Evaluation: T**

Objective: The objective of **Industrial and polymer Chemistry** is to make students familiar with chemistry of industrial products. It will also help students to the understand the chemistry of polymers.

Course Outcomes:

After successful completion of the course, student will be able to

Sl. No	Course Outcome	Bloom's Taxonomy Level
CO1	**Define** and get the detailed idea of petroleum products and petrochemical Industry.	BT1
CO2	**Explain** the concept of surface Coatings, fats, oils and detergents to understand their chemistry along with applications.	BT2
CO3	**Apply** the knowledge of chemistry to understand fertilizers, glass, ceramics and cement as well as their industrial application.	BT3
CO4	**Examine** the chemistry of polymers.	BT4

Detailed Syllabus:

Modules	Topics & Course content	Periods
I.	**Petroleum and Petrochemical Industry** Composition of crude petroleum, refining and different types of petroleum products and their applications, fractional Distillation (principle and process), cracking (thermal and catalytic cracking), reforming petroleum and non-petroleum fuels (LPG, CNG, LNG, biogas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.	**18**

II.	**Surface Coatings and Fats-Oils-Detergents** **Surface Coatings**: Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings, paints and pigments-formulation, composition and related properties, oil paint, vehicle, modified oils, pigments, toners and lakes pigments, fillers, thinners, emulsifying agents. **Fats-Oils-Detergents**: Fats and oils, natural fat, edible and inedible oil of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oil, production of vanaspati and margarine, enzyme-based detergents, detergent powder, liquid soaps.	**18**
III.	**Fertilizers, Glass, Ceramics and Cement** **Fertilizers**: Different types of fertilizers, manufacture of the following fertilizers: urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate. **Glass and Ceramics**: Definition and manufacture of glasses, optical glass and colored glass, clay and feldspar, glazing, glazed porcelain, enamel. **Portland cement**: Composition and setting of cement, white cement.	**18**
IV.	**Chemistry of polymers** Definition, classification of polymers on the basis of composition, degree of polymerization, addition and chain growth polymerization, vinyl polymerization, ionic vinyl polymerization, Ziegler –Natta polymerization, vinyl polymers, homopolymers, co-polymers, graft copolymers, crystalline polymers, amorphous polymers, classification of polymers on the basis of structure of polymer, i.e., linear, branched, and cross linked; molecular weight of polymers, number average and weight average molecular weights.	**18**
Total		**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	-	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. *Industrial Chemistry*, Stocchi E.; 1st edition; 2012(reprint); Ellis Horwood Ltd. UK.

2. *Riegel's Handbook of Industrial Chemistry*, Kent J.A.; 10th edition; 2013; CBS Publishers, New Delhi.

Reference Books:

1. Felder, R.M. and R. W. Rousseau, R.W: *Elementary Principles of Chemical Processes*, 4th edition;2004, Wiley Publishers, New Delhi.

2. Gowariker, V.R.; *Polymer science*; 4th edition; 2015; New Age International Pvt. Ltd.

SYLLABUS (8TH SEMESTER)

Advanced Course/Subject Name: Material Chemistry			**Subject Code: CHY012M803**
L-T-P-C – 4-0-0-4	**Credit Units: 4**	**Level 400**	**Scheme of Evaluation: T**

Objective: The objective of **Material Chemistry** is to make students familiar with the properties of Liquid Crystals and nano materials. It will also help students to understand synthesis and applications of silicate and alloy in industries.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl. No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Identify** the compounds or materials having distinctive electrical and optical properties.	BT1
CO2	**Explain** the applications of silicates in glass and ceramic industries.	BT2
CO3	**Apply** the properties of materials in various forms, including liquid crystals and nanomaterials, to gain a deeper understanding of their characteristics.	BT3
CO4	**Analyze** the chemical composition and reactions involved in batteries and alloys.	BT4

Detailed Syllabus:

Modules	**Topics & Course Content**	**Periods**
I	**Electrical and optical properties** Band theory, conductors, insulators and semi-conductors. Intrinsic and extrinsic semiconductors, Superconductivity and examples of superconducting materials, Ferroelectric and Piezoelectric materials, Conductors; variation of conductivity with temperature, semiconductors; p and n types, pn- junction, Photoconduction, photo voltaic cell and photo galvanic cell – solar energy conversion, organic semiconductors. Piezoelectric, pyro-electric and ferroelectrics (introduction and application). photoluminescence.	**18**
	Silicate Industries **Glass:** Glassy state and its properties, classification, manufacture and processing of glass, composition and properties of the following types of glasses:	**18**

	soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass. **Ceramics*:*** Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides.	
III	**Liquid Crystals and nano materials** **Liquid Crystals**: Mesomorphic behavior, thermotropic liquid crystals, positional order, bond orientational order, nematic and smectic mesophases; homeotropic, planar and schlieren textures, twisted nematics, chiral nematics, smectic A and smectic C phases, optical properties of liquid crystals. Lyotropic phases. **Nanomaterials**: Fundamentals, novel optical properties of nano materials, characterization and fabrication, self-assembled nanostructures. Control of nano-architectures: 1-D, 2-D and 3-D control. Carbon nanotubes.	**18**
IV	**Batteries and Alloys** **Batteries:** Primary and secondary batteries, battery components and their role, characteristics of battery, working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. fuel cells, solar cell and polymer cell. **Alloys:** Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.	**18**
TOTAL		**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	**-**	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. *Material Science and Engineering*, *An Introduction*; Callister, W.D., 8th edition, 2017,Wiley and sons.
2. *Handbook of Liquid Crystals*, Kelker and Hatz, Chemie Verlag.; 2nd edition, 2014

Reference Books:

1. Keer, H.V.; *Principles of the Solid State*, 4th edition, 2017; Wiley Eastern.

2. Anderson, J.M. Leaver, K.D., Rawlings, R.D.; *Materials Science*, 4th edition, 2003; ELBS.

SYLLABUS (8th SEMESTER)

Subject Name: Biochemistry and Natural Products **Subject Code: CHY012M804**

L-T-P-C: 4-0-0-4 **Credit Units: 4** **Level: 400** **Scheme of Evaluation: T**

Objective: The objective of **Biochemistry and Natural products** is to provide concept related to biomolecules and natural products.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Understand** the concept of various biomolecules and natural products.	BT1
CO2	**Explain** the structure and reactions of biomolecules and natural products.	BT2
CO3	**Apply** basic concepts of biochemistry to understand roles of biomolecules as well as metabolism process in biological systems.	BT3
CO4	**Analyze** the structures of various biomolecules and natural products.	BT4

Detailed Syllabus:

Modul es	Topics / Course content	Periods
I.	**Vitamins, minerals and enzyme** Classification and nomenclature of vitamins. Need for vitamin in body, Types of vitamins, water soluble and fat-soluble vitamins, Sources, deficiency diseases and structures of vitamin A1, vitamin B12, Vitamin C (Cyanocobalamine), vitamin D vitamin E and vitamin K. Role of minerals in body, iodine deficiency and remedy. Classification and nomenclature, prosthetic groups, cofactors of enzyme, properties of enzymes as catalysts, specific activity, turn over number and catalytic center activity. Isolation of enzymes from different sources.	**18**
II.	**Amino acids, peptides and proteins** Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis. Study of peptides: Determination of their primary structures, end group analysis, methods of peptide synthesis. Proteins: Overview of primary, secondary, tertiary and quaternary structure of proteins. Protein denaturation/ renaturation.	**18**
III	**Carbohydrate Chemistry** Carbohydrates: Definition, classification of carbohydrates, general idea of monosaccharides, configuration of the hydroxyl groups in the monosaccharides, open chain and ring structure of glucose, reactions of glucose: osazone formation, bromine – water oxidation etc., concept of mutarotation, anomers, epimers, oligosaccharides and polysaccharides.	**18**
IV	**Alkaloids and Terpeneoids** Natural occurrence, General structural features, Isolation and their physiological action. Structure elucidation and synthesis of Nicotine. Medicinal importance of Nicotine, Quinine, Morphine, Cocaine, and Reserpine. Terpenes: Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral, Neral and α-terpineol.	**18**
	Total	**72**

Credit Distribution		
Theory/ Tutorial	Practicum	Experimental Learning
72 hrs	-	48 hrs (Industry visit, lab visit, Field visit, Survey etc.)

Text Books:

1. *Organic Chemistry*, Finar I. L. 6th edition, (Low price), 2017, Pearson Education.
2. Advanced Organic Chemistry, by B S Bahl and Arun Bahl, S. Chand Publications.

Reference Books:

1. *Organic Chemistry* by Mukherji, Singh, Kapoor and Dass, New Age International Publishers.
2. Organic Chemistry, Stanley H. Pine, 5th edition, 2010, McGraw-Hill Bool .
3. Organic Chemistry, Solomons T. J., 11th revised edition, 2013, John Wiley & Sons Inc.