GURU KASHI UNIVERSITY

Master of Science in Chemistry

(M.Sc. Chemistry)

Session: 2025-26

Faculty of Sciences, Humanities and Languages

Graduate Attributes of the Programme: -

Programme learning outcomes: An Postgraduate degree is awarded to students who have demonstrated the achievement of the outcomes located at level 6.5:

Element of the descriptor: NHEQF level descriptors.

Graduate Attributes of the Programme: -

Type of learning outcomes	**The Learning Outcomes Descriptors**
Graduates should be able to demonstrate the acquisition of:	
Learning outcomes that are specific to disciplinary/interdisciplinary areas of learning	Apply knowledge and experimental skills to synthesize natural products, drugs and analyze chemicals of immediate need for the society and relevance to chemical and allied industries.
	Develop inter-disciplinary skills of students in the research areas to evaluate the reaction mechanism, assign the final product, Inorganic ions and their complexes in biophysical entities and importance in daily life.
	Demonstrate the knowledge and skills in various fields of chemistry for determining the molecular structure using various techniques.
Generic learning outcomes	Problematize, synthesize, and articulate issues and design research proposals,
	Develop appropriate tools for data collection for research,
	The ability to use appropriate statistical and other analytical tools and techniques for the analysis of data collected for research and evaluation studies,
	Define problems, formulate appropriate and relevant research questions, formulate hypotheses, test hypotheses using quantitative and qualitative data, establish hypotheses, make inferences based on the analysis and interpretation of data, and predict cause-and-effect relationships,
	Follow basic research ethics and skills in practicing/doing ethics in the field/ in one's own research work.

Programme Learning outcomes: An Postgraduate Certificate is awarded to students who have demonstrated the achievement of the outcomes located at level 6.5 :

Element of the Descriptor	**Programme learning outcomes relating to Undergraduate Certificate**
The graduates should be able to demonstrate the acquisition of:	
Knowledge and understanding	Advanced knowledge and understanding of the research principles, methods, and techniques applicable to the chosen field(s) of learning or professional practice
	Procedural knowledge required for performing and accomplishing complex and specialized and professional tasks relating to teaching, and research and development.
	General, technical and professional skills required to perform and accomplish tasks
	Advanced knowledge about a specialized field of enquiry with a critical understanding of the emerging developments and issues relating to one or more fields of learning,
General, technical and professional skills required to perform and accomplish tasks	Listen carefully, read texts and research papers analytically and present complex information in a clear and concise manner to different groups/audiences,
	Communicate, in a well-structured manner, technical information and explanations, and the findings/results of the research studies undertaken in the chosen field of study,
	Evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.
Application of knowledge and skills	Apply the acquired advanced theoretical and/or technical knowledge about a specialized field of enquiry or professional practice and a range of cognitive and practical skills to identify and analyze problems and issues, including real-life problems, associated with the chosen fields of learning.
Generic learning outcomes	Pursue self-paced and self-directed learning to upgrade knowledge and skills, including research-related skills, required to pursue a higher level of education and research.
Constitutional, humanistic, ethical, and moral values	Embrace and practice constitutional, humanistic, ethical, and moral values in one's life, Adopt objective and unbiased actions in all aspects of work related to the chosen fields/subfields of study and professional practice,

	Support relevant ethical and moral issues by formulating and presenting coherent arguments.
Employability and job-ready skills, and entrepreneurship skills and capabilities/qualities and mindset	Adapting to the future of work and responding to the demands of the fast pace of technological developments and innovations that drive the shift in employers' demands for skills, particularly with respect to the transition towards more technology-assisted work involving the creation of new forms of work and rapidly changing work and production processes.
Credit requirements	A 1-year master's programme builds on a bachelor's degree with Honours/ Honours with Research and requires of 46 credits for individuals who have completed a Bachelor's degree (Honours/ Honours with Research).
Entry requirements	B.Sc. in relevant subjects with at least 45% marks in the aggregate.

Semester: I									
Course Code	**Course Name**	**Type of Course**	**L**	**T**	**P**	**Cr.**	**Int.**	**Ext.**	**Total**
MCH1400	Inorganic Chemistry	Core Course (Theory)	3	0	0	3	25	50	75
MCH1401	Organic Chemistry	Core Course (Theory)	3	0	0	3	25	50	75
MCH1403	Analytical Chemistry	Core Course (Theory)	4	0	0	4	30	70	100
MCH1404	Organometallic Chemistry	Core Course (Theory)	4	0	0	4	30	70	100
MCH1405	Inorganic Chemistry Lab	Core Practicum	0	0	2	1	10	15	25
MCH1406	Organic Chemistry Lab	Core Practicum	0	0	2	1	10	15	25
IKS0016	Indian Knowledge System	IKS Course	4	0	0	4	30	70	100
Discipline Elective–I (Choose any one of the following)									
MCH1408	Environmental Chemistry	**Discipline Elective-I**	4	0	0	4	**30**	**70**	**100**
MCH1409	Bioinorganic Chemistry								
Total			**22**	**0**	**4**	**24**	**190**	**410**	**600**

Semester: II									
Course Code	**Course Name**	**Type of Course**	**L**	**T**	**P**	**Cr.**	**Int.**	**Ext.**	**Total**
MCH2450	Advanced Organic Synthesis	Core Course	4	0	0	4	30	70	100
MCH2451	Spectroscopy: Techniques of Analysis	Core Course	4	0	0	4	30	70	100
MCH2452	Physical Chemistry	Core Course	3	0	0	3	25	50	75
MCH2453	Heterocyclic Chemistry	Core Course	4	0	0	4	30	70	100
MCH2454	Physical Chemistry Lab	Core Practicum	0	0	2	1	10	15	25
MCH2455	Industrial Chemistry	Skill Course	2	0	0	2	15	35	50
Discipline Elective–II (Choose any one of the following)									
MCH2456	Biology for Chemists	**Discipline Elective-III**	4	0	0	4	**30**	**70**	**100**
MCH2457	Chemistry of Natural Products								
Total			**21**	**0**	**2**	**22**	**170**	**380**	**550**

Programme learning outcomes: An postgraduate Diploma is awarded to students who have demonstrated the achievement of the outcomes located at level 6 :

Element of the Descriptor	**Programme learning outcomes relating to Undergraduate Diploma**
The graduates should be able to demonstrate the acquisition of:	
Knowledge and understanding	Advanced cognitive and technical skills required for performing and accomplishing complex tasks related to the chosen fields of learning.
	Advanced cognitive and technical skills required for evaluating research findings and designing and conducting relevant research that contributes to the generation of new knowledge.
Skills required to perform and accomplish tasks	Specialized cognitive and technical skills relating to a body of knowledge and practice to analyze and synthesize complex information and problems
	Procedural knowledge required for performing and accomplishing complex and specialized and professional tasks relating to teaching, and research and development
Application of knowledge and skills	Apply advanced knowledge relating to research methods to carry out research and investigations to formulate evidence-based solutions to complex and unpredictable problems.
Generic learning outcomes	Develop appropriate tools for data collection for research,
Constitutional, humanistic, ethical, and moral values	Support relevant ethical and moral issues by formulating and presenting coherent arguments, Follow ethical principles and practices in all aspects of research and development, including inducements for enrolling participants, avoiding unethical practices such as fabrication, falsification or misrepresentation of data or committing plagiarism.
Employability and job-ready skills, and entrepreneurship skills and capabilities/qualities and mindset	Exercising full personal responsibility for the output of own work as well as for group/team outputs and for managing work that is complex and unpredictable requiring new strategic approaches.
Credit requirements	The 2-year Master's programme builds on a 3-year/6-semester bachelor's degree and requires a total of a minimum of 90 credits from the first and second years of the programme, with a 46 credits in the first year and 44 credits in the second year of the programme at level 6.5 on the NHEQF.

Entry requirements	B. Sc. (Honours)/ B.Sc. (Honours with Research) Degree in Chemistry (4 Years) **OR** One year PG Diploma in Chemistry with 40 credits in the concerned subject and with at least 45% marks or equivalent CGPA in aggregate, after 3 year Bachelor Degree.

Semester: III									
Course Code	**Course Name**	**Type of Course**	**L**	**T**	**P**	**Cr.**	**Int.**	**Ext.**	**Total**
MCH3500	Basics of Research Methodology	Core Course	4	0	0	4	30	70	100
MCH3501	Polymer Chemistry	Core Course	4	0	0	4	30	70	100
MCH3502	Service Learning	Skill Course	0	0	4	2	15	35	50
Discipline Elective–III (Choose any one of the following)									
MCH3503	Supramolecular Chemistry	**Discipline Elective-III**	4	0	0	4	**30**	**70**	**100**
MCH3504	Chemical Dynamics and Electroanalytical Techniques								
Discipline Elective–IV (Choose any one of the following)									
MCH3505	Pesticide Chemistry	**Discipline Elective-IV**	4	0	0	4	**30**	**70**	**100**
MCH3506	Chemistry of Cosmetics And Perfumes								
Discipline Elective–V (Choose any one of the following)									
MCH3507	Green Chemistry	**Discipline Elective-V**	4	0	0	4	**30**	**70**	**100**
MCH3508	Biophysical Chemistry								
Total			**20**	**0**	**4**	**22**	**165**	**385**	**550**

Semester: IV									
Course Code	**Course Name**	**Type of Course**	**L**	**T**	**P**	**Cr.**	**Int.**	**Ext.**	**Total**
MCH4550	Dissertation	Research Based Skill	**0**	**0**	**0**	12	200	100	300
MCH4551	Nanotechnology	Core Course	**4**	**0**	**0**	4	30	70	100
MCH4552	Scientific Research and Technical Writing	Employability Skill	**2**	**0**	**0**	2	15	35	50
Discipline Elective–VI (Choose any one of the following)									
MCH4553	Chemistry of Main Group Elements, Theories of Acids and Bases	**Discipline Elective-VI**	4	0	0	4	**30**	**70**	**100**
MCH4554	Fuel Chemistry								
Total			10	**0**	**0**	**22**	**275**	**275**	**550**
Grand Total			**73**	**0**	**10**	**90**	**800**	**1450**	**2250**

SEMESTER-I

Course Title: Inorganic Chemistry	L	T	P	Cr.
Course Code: MCH1400	3	0	0	3

Total hours: 45

Learning Outcomes:

After the completion of this course, the learner will be able to:

1. Understand Coordination Chemistry – Explain bonding theories (VBT, CFT, MOT), isomerism, and electronic spectra of coordination compounds.
2. Analyze Reaction Mechanisms – Describe substitution reactions, trans effect, electron transfer mechanisms, and ligand field effects.
3. Evaluate Spectral & Magnetic Properties – Interpret f-orbital behavior, spectral transitions, and magnetic moment calculations in lanthanides and actinides.
4. Apply Group Theory – Classify molecules by symmetry, use character tables, and apply symmetry principles in spectroscopy.

Course Content

UNIT I **12 hours**

Coordination Chemistry

Werner's Theory of Coordination Compounds, Types of Coordination Complexes (Geometrical and Structural Isomerism), Valence Bond Theory (VBT) in Coordination Compounds, Crystal Field Theory (CFT): Splitting of d-Orbitals, Octahedral and Tetrahedral Fields, Crystal Field Stabilization Energy (CFSE), Molecular Orbital Theory (MOT) for Coordination Compounds, Electronic Spectra of Transition Metal Complexes (d-d Transitions, Charge Transfer Spectra), Factors Affecting the Color of Complexes

UNIT II **11 hours**

Reaction Mechanisms of Coordination Compounds

Substitution Reactions in Octahedral and Square Planar Complexes, Trans Effect and Its Applications, Electron Transfer Reactions (Inner and Outer Sphere Mechanisms), Ligand Field Effects and Their Role in Reactivity, Determination of Magnetic Moments

UNIT III **11 hours**

Spectral and Magnetic Properties of Inner Transition Elements:

Nature of f-orbitals and shielding effect, Laporte Selection Rule and its Relaxation, Factors Affecting Spectral Properties Crystal field effects, Spin-orbit coupling, f-f transitions and hypersensitivity, Color of Lanthanide and Actinide Ions, Charge Transfer Spectra in Actinides, Orbital and Spin Contribution to Magnetic Moments, Effective Magnetic Moment Calculation using: Spin-only formula, L-S coupling (Russell-Saunders coupling), Magnetic Behavior in Lanthanides vs. Actinides, Comparison with Transition Metals

UNIT IV **11 hours**

Group Theory: Introduction, Molecular Symmetry & point groups, Symmetry elements and operators, classes of symmetry operation, Symmetry classification of molecules, Matrix representation of symmetry operations, representation of groups, character, reducible and irreducible representations, Great Orthogonality theorem, Character tables, symmetry properties of Hamiltonian operator, Mutual exclusion principle.

Transaction Mode- Open Talk, Group Discussion, Video Based Teaching, Quiz, E Team Teaching, Collaborative Teaching, Peer Teaching, Case Analysis, Role- Playing, Ted Talks, Flipped Teaching

SUGGESTED READINGS

1. ***Coordination Chemistry***

- *Cotton, F. A., & Wilkinson, G. (1999). Advanced Inorganic Chemistry (6th ed.). Wiley.*
- *Miessler, G. L., Fischer, P. J., & Tarr, D. A. (2013). Inorganic Chemistry (5th ed.). Pearson.*

2. ***Reaction Mechanisms of Coordination Compounds***

- *Basolo, F., & Pearson, R. G. (1988). Mechanisms of Inorganic Reactions (2nd ed.). Wiley..*

3. ***Spectral and Magnetic Properties of Inner Transition Elements***

- *Cotton, S. (2006). Lanthanides and Actinides. Macmillan.*
- *Sinha, S. P. (1983). Systematics and Properties of the Lanthanides. Springer.*

4. ***Group Theory***

- *Cotton, F. A. (1990). Chemical Applications of Group Theory (3rd ed.). Wiley.*
- *Bishop, D. M. (1993). Group Theory and Chemistry. Dover Publications.*
- *Carter, R. L. (1998). Molecular Symmetry and Group Theory. John Wiley & Sons.*

Course Title: Organic Chemistry	L	T	P	Cr.
Course Code: MCH1401	3	0	0	3

Total hours: 60

Learning Outcomes

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

1. Recognize the main types of reactive intermediates and ways to generate these reactive intermediates.
2. Propose a mechanism to design experiments and determine reaction intermediates.
3. Analyze the fundamental organic reactions such as SN^2, SN^1, E2, E1, and mechanism of these reactions.
4. Evaluate the stereochemical aspects and modes of pericyclic, electrocyclic reactions and sigma tropic rearrangements.

Course Content

UNIT I **12 hours**

Carbocation: Generation, Structure, Stability, Application of NMR spectroscopy in the detection of Carbocation, allylic and benzylic carbocations

Carbanions: Generation, Structure, stability, stereochemistry, Tautomerism, Prototropy and general reactions; Carbenes: Formation, Structure, Singlet & Triplet carbene, Stereochemsitry and reactions; Nitrenes: Formation, Structure Singlet & Triplet nitrene, Stereochemsitry and reactions; Arynes: Formation, Structure and reactions; Free radicals: Formation, Structure, Stability, Stereo-chemistry and reactions.

UNIT II **11 hours**

Nature of Bonding in Organic Molecules : Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's Rule, anti-aromaticity, homo-aromaticity.

Techniques used for determination of reaction mechanism: Use of optical, Stereochemical anisotopic techniques. Reaction studies from identification of products, trapping of intermediate, cross over experiments, use of catalyst

UNIT III **11 hours**

Elimination Reactions: E2, E1and E1CB mechanism, Stereochemistry product ratio, Orientation of double bond, Hofman Rule, Saytzeff Rule; Factors Governing E2 & E1 Mechanism; Elimination versus Substitution Dehalogenation by zinc; Aromatic Elimination: Benzenes, Nucleophillic

aromatic substitution, addition elimination.

UNIT IV **11 hours**

Pericyclic Reactions: Molecular Orbital symmetry, Frontier Orbitals of ethylene, 1, 3- butadiene, 1, 3, 5- hexatrience an allyl system; Classification of Pericyclic reactions; Woodward-Hoffman rule,Claisen and Cope rearrangement reactions.

Transaction Mode- Open Talk, Group Discussion, Video Based Teaching, Quiz, E Team Teaching, Collaborative Teaching, Peer Teaching, Case Analysis, Role- Playing, Ted Talks, Flipped Teaching

Suggested Readings:

- *Samec, J. S., &Bäckvall, J. E. (2002). Ruthenium-Catalyzed Transfer Hydrogenation of Imines by Propan-2-ol in Benzene. Chemistry–A European journal.*
- *Carey, F. A., &Sundberg, R. J. (2007). Advanced organic chemistry: part A: structureand mechanisms. Springer Science & Business Media.*
- *Sykes, P. (1986). A guidebook to mechanism in organic chemistry. Pearson Education India.*
- *Ingold, C. K. (1953). Structure and mechanism in organic chemistry.*
- *Pursell, D. P. (2009). Adapting to student learning styles: Engaging students with cell phone technology in organic chemistry instruction. Journal of chemical education.*

Course Title: Analytical Chemistry	L	T	P	Cr.
Course Code: MCH1403	4	0	0	4

Total hours: 60

Learning Outcomes

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

1. Apply information regarding sampling, sample preparations, and sample dispersion techniques.
2. Analyze the sample with the best utilization of technique that provides structure information.
3. Identify the adulterants in some common food items like coffee powder.
4. Evaluate the nutritional value of foods, idea about food processing and food preservation.

Course Content

UNIT I **14 hours**

Introduction to Analytical Chemistry

Definition and Scope of Analytical Chemistry, Types of Analysis: Qualitative and Quantitative Analysis, Errors in Analysis: Accuracy, Precision, Sensitivity, Selectivity, Types of errors: Systematic, Random, and Gross Errors, Minimization and Statistical Treatment of Data (Mean, Standard Deviation, Confidence Limits, T-tests),

UNIT II **13 hours**

Chromatography: Definition, general, Introduction on principles of chromatography, paper chromatography, TLC etc, Paper chromatographic separation of mixture of metal ion (Fe3+and Al3+) To compare paint samples by TLC method. Ion-exchange: Column ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible) High Performance Liquid Chromatography (HPLC).

UNIT III **16 hours**

Analysis of cosmetics: Major and minor constituents and their function; Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate; Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration

UNIT IV **14 hours**

Suggested Applications (Any one):

To study the use of phenolphthalein in traps cases.

To analyze arson accelerants

To carry out analysis of gasoline

Suggested Instrumental demonstrations:

Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by Flame photometry; Spectrophotometric determination of Iron in Vitamin / Dietary Tablets; Spectrophotometric identification and determination of Caffeine and Benzoic Acid in Soft Drinks.

Transaction Mode- Collaborative Teaching, Open Talk, Group Discussion, Video Based Teaching, Quiz, E Team Teaching, Peer Teaching, Case Analysis, Ted Talks, Flipped Teaching

SUGGESTED READINGS

- *Willard, H. H., Merritt Jr, L. L., Dean, J. A., & Settle Jr, F. A. (1988). Instrumental methods of analysis.*
- *Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Principles of instrumental analysis. Cengage learning.*
- *Harris, D. C. (2010). Quantitative chemical analysis. Macmillan.*
- *Day, R. A., & Underwood, A. L. (1991). Quantitative analysis (Vol. 27). NJ: Prentice*

Course Title: Organometallic Chemistry	L	T	P	Cr.
Course Code: MCH1404	4	0	0	4

Total hours: 60

Learning Outcomes

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

1. Elaborate the classification of organometallic compounds based on bond type and use of modern methods to characterize organometallic compounds.
2. Have insight into the use of Estimate the hapticity in organometallic compounds.
3. Analyze the reaction types and Mechanism in various organometallic complexes for use in efficient catalytic processes.
4. Recognize the important applications of organometallic homogeneous catalysis in the production of large-scale (bulk) and smaller-scale (fine chemicals) production.

Course Content

UNIT I **16 hours**

Organometallic Compounds

Definition and classification of organometallic compounds Afterbasis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe,Co and Ni using VBT. π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

UNIT II **15 hours**

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls. Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures,

Schlenk equilibrium.

UNIT III **14 hours**

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene,Reaction Kinetics and Mechanism Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

UNIT IV **14 hours**

Catalysis by Organometallic Compounds Study of the following industrial processes and their mechanism Alkene hydrogenation (Wilkinson's Catalyst), Hydroformylation (Co salts), Wacker Process, Synthetic gasoline (Fischer Tropsch reaction), Synthesis gas by metal carbonyl complexes

Transaction Mode- Video Based Teaching, Open Talk, Group Discussion, Quiz, E Team Teaching, Collaborative Teaching, Peer Teaching, Case Analysis, Role- Playing, Ted Talks, Flipped Teaching

SUGGESTED READINGS

- *Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann, M., & Grimes, R. (2018). Advanced inorganic chemistry (Vol. 6, p. 1455). New York: Wiley.*
- *Shriver, D. F., Atkins, P. W., & Langford, C. H. (1999). Inorganic chemistry.*
- *Hughes, M. N. (2011). The inorganic chemistry of biologicalprocesses 2nd edn. FEBS LETTERS*

Course Title: Inorganic Chemistry Lab	L	T	P	Cr.
Course Code: MCH1405	0	0	2	1

Learning Outcomes

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

1. Apply the methods involved in preparation and estimation of inorganic metals.
2. Analyze the methods involved in analytical studies.
3. Demonstrate the chromatographic techniques that help in separation of amino acids and their presence in unknown sample can be determined.
4. Evaluate the qualitative and quantitative methods of analysis that are helpful in future research studies.

Course Contents

PREPARATION AND ESTIMATIONS

1. Preparation of Tris-thioureacuprous chloride.
2. Estimation of Cu, and Chloride.
3. Preparation of K3 [Fe (C2O4)3].
4. Estimation of iron.
5. Estimation of Cr and oxalate.

CHROMATOGRAPHIC SEPARATION OF IONS

6. Paper chromatography
7. Thin layer chromatography
8. Column chromatography

COMPLEXOMETRIC TITRATIONS

9. Determination of calcium in the presence of magnesium using EDTA as titrant.

REDOX TITRATIONS

10. Determination of chlorate, preparation of 0.1M cerium (IV) sulphate solution.
11. Determination of hydrogen sulphide.
12. Determination of antimony & arsenic.

Note: Each student is required to perform at least ten to twelve experiments.

Transaction Mode- Team Teaching, Demonstration, Open Talk, Collaborative Teaching, Group Discussion, Video Based Teaching, Quiz, E Team Teaching, Case Analysis

SUGGESTED READINGS

- *Vogel, A. I., Mendham, J., Denney, R. C., Barnes, J. D., & Thomas, M. (2009). Vogel's quantitative chemical analysis. Pearson.*
- *Philip P. Power, (2018). Inorganic synthesis. John Wiley & Sons..Ltd.,NewDelhi.*

Course Title: Organic Chemistry Lab	L	T	P	Cr.
Course Code: MCH1406	0	0	2	1

Learning Outcomes

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

1. Apply solubility behavior and extraction method required for identification and preparation of derivatives.
2. Analyze the spectral techniques for product analysis.
3. Perform and evaluate the mechanism of name reactions essential for synthesis of organic compounds experimentally.
4. Purify organic compounds by crystallization, precipitation and distillation methods.

Course Contents

1. Qualitative Organic Analysis

Separation and purification of components of binary mixture (Solid/solid, solid/liquid and liquid/liquid) Afterbasis of solubility behavior and solvent extraction and their identification and conformation by chemical tests and preparation of suitable derivative. Preparative TLC separation for IR and PMR spectral studies of the respective component

2. Organic Synthesis

Benzoylation	Hippuric acid
Oxidation	Adipic acid/p-Nitrobenzoic acid Aldol condensation
Aldol condensation	Dibenzalacetone/Cinnamic acid Sandmeyer's reaction
Sandmeyer’s reaction	p-Chlorotoluene
Benzfused Heterocycles	Benzimidazole
Cannizzaro’s reaction	p-Chlorobenzaldehyde as substrate
Friedel Crafts reaction	S-Benzoylpropionic acid
Aromatic electrophilic substitution	p-Nitroaniline / p-Iodoaniline

Transaction Mode- Team Teaching, Demonstration, Open Talk, Collaborative Teaching, Group Discussion, Video Based Teaching, Quiz, E Team Teaching, Case Analysis

SUGGESTED READINGS

1. Furniss, B. S. (1989). Vogel's textbook of practical organic chemistry. Pearson Eductaion India.
2. Mann, F. G., & Saunders, B. C. (1975). Practical organic chemistry. Orient Blackswan.
3. Khurana, J. M., & Sharma, P. (2004). Chemo-selective reduction of α, β- unsaturatedaldehydes, ketones, carboxylic acids, and esters with nickel boride in methanol– water. Bulletin of the Chemical Society of Japan.

Course Title:- INDIAN KNOWLEDGE SYSTEM	L	T	P	Cr.
Course Code: IKS0016	4	0	0	4

Course Objectives:

This course focuses on introduction to science and technology of Indian Knowledge System and Indian perspective of modern scientific view.

Learning Outcome:

1. It aimed to instill in students a sense of rootedness and pride in India, along with an appreciation for its rich, diverse, ancient, and modern culture, knowledge systems, and traditions.
2. This course helps students understand the rich scientific and technological heritage of the country.
4. This course emphasizes and promotes the Indian concept of multidisciplinary learning systems, integrating them with modern science.
5. The course will underscore the importance of intellectual property rights in safeguarding Indian knowledge.

Course Content

Unit-I **7 Hours**

Ancient philosophy of Knowledge: Vedas, Vedangas, sutras – Gurukul parampara

Unit-II **8 Hours**

Astronomy in India: The Beginnings of Indian Astronomy - The Early Historical Period-The Siddhāntic Era - The Kerala School - Aryabhatta - Varahamihira-Bhaskara I – Brahamagupta- Bhaskara II – Brief notes on Astronomical instruments

Unit-III **8 Hours**

Chemistry in India: Early Chemical Techniques, Atomism in Vaiśeṣika - Rishi Kanad- Nagarjuna- Al-Bīrūnī', Vāgbhaṭa- Sushruta- Carak Metallurgy in India - Definition, Metallurgy in Harappan Civilization, Metallurgy of Gold- Copper-Zinc- Bronze - Iron and steel.

Unit-IV **7 Hours**

Developments in Mathematics: Number systems- Geometry- works of Pingala-Baudhayana- Jaina Mahavira-Sridharacharya – Madhava Siddanthas and Calender systems

Transactional Mode

Seminars, Group discussion, Team teaching, Focused group discussion, Assignments, Project-based learning, Simulations, reflection and Self-assessment

Suggested Readings

1. *A Concise History of Science in India – Bose, Sen & Subbarayappa- INSA Publications*
2. *Encyclopedia of Classical Indian Sciences- Roddam Narasimha, Universities Press*
3. *NCERT Modules of KPTI*

Course Title: Environmental Chemistry	L	T	P	Cr.
Course Code: MCH1408	4	0	0	4

Learning Outcomes

After completion of the course, the students will be able to

1. Apply understanding of atmospheric general circulation and the basic principles of physical and applied climatology and climate change for environmental protection.
2. Solve combustion problems and calculates the amount of pollutants emitted.
3. Describe methods for evaluating the hazards associated with environmental exposures to toxicants.
4. BOD and COD explained and taught experimentally necessary for obtaining values essential in industries releasing toxic wastes.

Course Content

UNIT I **17 hours**

Commonly used terms, environmental segments, **n**atural cycles of environment, environmental chemistry of water, water pollution, water treatment operations, advanced waste water treatment. Analysis of major and minor constituents in water, potable and industrial water, dissolved oxygen demand (COD), Biological oxygen demand (BOD).

UNIT II **12 hours**

Special features of forensic analysis: Sampling, Sample storage, classification of prisons, lethaldose, significance of LD 50 and LC 50.

UNIT III **14 hours**

The atmosphere and atmospheric chemistry, air pollutants, organic air pollutants, atmospheric analysis of gases, atmospheric analysis of particulates, soil formation, soil properties, analysis of soil sediments and biological specifications.

UNIT IV **16 hours**

Toxicological chemistry, toxicology of some organic compounds, reactions and rate of hazardous wastes, hazardous waste reduction and minimization and physical methods treatment of hazardous waste, chemical methods of treatment of hazardous waste.

Transaction Mode- Open Talk, Video Based Teaching, Group Discussion,

Quiz, E Team Teaching, Collaborative Teaching, Group Discussion, Ted talks, E team Teaching

SUGGESTED READINGS

- *De Anil, K. (2013). Environmental chemistry. New Age International.*
- *Fifield, F. W., & Haines, P. J. (Eds.). (2010). Environmental analytical chemistry. Wiley-Blackwell.*
- *Pabby, A. K., Rizvi, S. S., & Requena, A. M. S. (2008). Handbook of membrane separations: chemical, pharmaceutical, food, and biotechnological applications. CRC press.*
- *Aznar-Sánchez, J. A., García-Gómez, J. J., Velasco-Muñoz, J. F., & Carretero-Gómez, A.(2018). Mining waste and its sustainable management: Advances in worldwide research. Minerals.*
- *Rao, C. S. (2007). Environmental pollution control engineering. New Age International.*

Course Title: Bioinorganic Chemistry	L	T	P	Cr.
Course Code: MCH1409	4	0	0	4

Total hours: 60

Learning Outcomes

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

1. Describe the roles of metals and minerals in vital systems.
2. Analyze After factors that affect the absorption, distribution, metabolism and excretion of metals the relationship between energy and living systems.
3. Recognize the metal ion binding to biomolecules and their functions.
4. Interpret situations that may occur in the absence and excess of minerals.

Course Content

Unit I **15 hours**

Metal Ions in Biological Systems: Essential and trace elements, periodic survey of essential and trace elements, biological importance and relative abundance, Na^+/ K^+ ion pump.

Transport and Storage of Dioxygen: Oxygen carriers-Hb and Mb: Structure and mechanism of their function, cooperativity, inhibition and poisoning by ligands and metal ions, hemocyanins and hemerythrin, model complexes of iron, cobalt and copper

Unit II **14 hours**

Bioenergetics and ATP Cycle: Process concept to phosphate hydrolysis, Nucleotide transfer- DNA polymerase, phosphate transfer pyruvate kinase, phosphoglucomutase, created kinase, ATPase. Photosynthesis and respiration, Chlorophyll: structure, function and its synthetic model

Unit III **16 hours**

Bioredox Agents: Mechanism and application in organic syntheses intake of alcohol and its remedy.

Biochemistry of Iron: Availability of iron, competition for iron, iron toxicity and nutrition. Enzymes and their functioning, Vitamin B12 coenzyme, its function

Electron Transfer in Biology: Cytochromes-structure and function, CN^- and CO poisoning, Ferredoxin and rubredoxim.

Nitrogenase: Biological N2 fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model systems

Unit IV **15 hours**

Metal Storage, Transport: Ferritin, transferring and siderophores

Metalloenzymes: Zinc enzymes-carboxypeptidase and carbonic anhydrase, Copper enzymes superoxide dismutase

Calcium in Biology: Calcium in living cell, transport and regulation, molecular aspects of intra-molecular processes

Metals in Medicine: Metal deficiency and disease, toxic effects of antibiotics and related compounds, chelate therapy

Transaction Mode- Open Talk, Video Based Teaching, Group Discussion, Quiz, E Team Teaching, Collaborative Teaching, Case Analysis, Role-Playing, Ted Talks, Flipped Teaching

SUGGESTED READINGS

- *Principles of bioinorganic chemistry, S. J. Lippard and Berg, University Science Books.*
- *Inorganic biochemistry, Vol I and II Ed. G. L. Eichhorn, Elsevier.*
- *J.E. Huheey : Inorganic chemistry III & IV Ed. Pearson Education Asia – (2002).*
- *F.A. Cotton and G. Wilkinson, Advanced inorganic chemistry, 5th Edition.*
- *Progress in inorganic chemistry, Vols 18 and 38 Ed., J. J. Lippard, Wiley.*

SEMESTER-II

Course Title: Advanced Organic Synthesis	L	T	P	Cr.
Course Code: MCH2450	4	0	0	4

Total hours: 60

Learning Outcomes

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

1. Illustrate the mechanism of rearrangement reaction, use synthetic reagent of oxidation and reduction for solving the problems.
2. Explain about structure, reactivity and preparation of poly nuclear and macro ring compounds.
3. Acquire the skills for correct stereochemical assignment and interpretation in rather simple organic molecules.
4. Predict the role of various reagents in organic synthesis.

Course Content

UNIT I **14 hours**

Rearrangements

General mechanistic considerations – nature of migration, migratory aptitude, memory effects; A detailed study of the following rearrangements: Pinacol- pinacolone, Wagner-Merwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt- Eistert synthesis, Neber, Beckmann, Hofmann, Curtius, Schmidt, Baeyer-Villiger, Shapiro reaction

UNIT II **16 hours**

Polynuclear Compounds & Macro-Ring Compounds

Introduction, comparative study of aromatic character of Linear and non-Linear- ortho-fused polynuclear hydrocarbons, ortho-and peri-fused polynuclear hydrocarbons, General method of preparation and reactions of indene, fluorene anthracene and phenanthrene. Modern methods of synthesis of macro ring compounds-civiton, muscone and catenoids.

UNIT III **17 hours**

Heterocyclic Synthesis

Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reaction

Six-Membered Heterocycles with one Heteroatom

Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium & thiopyrylium salts and pyridones Synthesis and reactions of quinolizinium and benzopyrylium salts, coumarins and chromone

UNIT IV **13 hours**

Reagents in Organic Synthesis: Use of the following reagents in organic synthesis and functional group transformations; Complex metal hydrides, Gilman's reagent, lithium dimethylcuprate, lithium disopropylamide (LDA) dicyclohexylcarbodimide. 1, 3- Dithiane(reactivity umpolung), trimethylsilyl iodide, tri-n-butyltin hybride, Woodward hydroxylation, osmium tetroxide, DDQ, selenium dioxide, phase transfer catalysts, crown ethers and Merrifield resin, Peterson's synthesis, Wilkinson's catalyst, Baker yeast.

Transaction Mode- Video Based Teaching, Open Talk, Group Discussion, Quiz, E Team Teaching, Collaborative Teaching, Peer Teaching, Role-Playing, Ted Talks, Flipped Teaching

SUGGESTED READINGS

- *Kalsi, P. S. (2007). Spectroscopy of organic compounds. New age international.*
- *Chandrasekhar, S. (1987). Product stability in kinetically-controlled organic reactions. Chemical Society Reviews.*

Course Title: Spectroscopy: Techniques of Analysis	L	T	P	Cr.
Course Code: MCH2451	4	0	0	4

Total hours: 60

Learning Outcomes

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

1. Apply formalisms based on molecular symmetry to predict spectroscopic properties.
2. Analyze and interpret spectroscopic data collected by different spectroscopic techniques.
3. Solve problems related to the structure determination and study molecular interactions by choosing suitable spectroscopic methods.
4. Assess fragmentation analysis of organic and inorganic compounds.

Course Content

UNIT I **16 hours**

Nuclear Magnetic Resonance

The Nuclear spin, Larmor frequency, the NMR isotopes, population of nuclear spin level, spin and spin lattice relaxation. Measurement techniques (CW & FT method), solvent used. Chemical shift, reference compounds, shielding constant, range of typical chemical Shifts simple application of chemical shifts, ring current and aromaticity, shifts for H and 13 C. -Spin-spin interactions, Low and High resolution spectra with various examples, Correlation of H bound to carbon, H bound to other nuclei such as nitrogen, oxygen, sulphur, Complex spin-spin interaction, between two or more nuclei. Effect of chemical exchange, fluxional molecules, hindered rotation on NMR spectrum Karplus relationship, nuclear magnetic double resonance, chemically induced dynamic nuclear polarization. Brief introduction to multipulse NMR spectroscopy, Application of structure elucidation of simple organic molecules Lanthanide shift

UNIT II **18 hours**

Mass Spectroscopy

Elementary theory - Measurement techniques (EI, CI, FD, FAB), Resolution, exact masses of nuclides, Molecular ions, isotope ions, fragment ions of odd and even electron types, rearrangement ions, Factors affecting cleavage patterns, simple cleavage, cleavages at a hetero atom, multicentre fragmentations rearrangements, Reteroiels – Alder fragmentation. Cleavage associated with common functional groups (Aldehydes, ketones cyclic and acyclic esters, alcohols, olefins, aromatic compounds amines) - Special

methods of GCMS, high resolution MS, Introduction to radical anion mass spectroscopy. Interpretation of the spectrum of an unknown compound

UNIT III **15 hours**

Electron Spin Resonance Spectroscopy

Features of ESR spectra, measurement technique hyperfine coupling in isotropic system (C 5 H 5 , C 6 H 6 , C 14 H 10 , biphenyl) Anisotropic splitting, Electron – electron interaction, Transition metal complexes g-value and factors affecting g- value, zerofield splitting, Kramer's degeneracy, Rate of electron exchange, Application to p -benzoseniquinone DPPH, pyrazine

UNIT IV **11 hours**

Mossbaur Spectroscopy

Introduction, principles, conditions of MB spectra, parameters from MB spectra. Isomer shift electric quadrupole interaction, magnetic interaction, use of additive partial quadrupole splittings to predict quadrupole coupling. Application of compounds, to biological systems to surface study

Transaction Mode- Video Based Teaching, Open Talk, Group Discussion, Quiz, E Team Teaching, Collaborative Teaching, Peer Teaching, Role-Playing, Ted Talks, Flipped Teaching

SUGGESTED READINGS

- *Pang, P., Lai, Y., Zhang, Y., Wang, H., Conlan, X. A., Barrow, C. J., & Yang, W. (2020). Recent advancement of biosensor technology for the detection of microcystin-LR. Bulletin of the Chemical Society of Japan.*
- *Silverstein, R. M., & Webster, F. X. (2013). Spectroscopic identification of organic compound 6thed John Wiley and Sons. Inc. New York.*
- *Sarangi, A. K., Mahapatra, B. B., & Sethy, S. K. (2018). Synthesis and characterization of tetranuclear metal complexes with an octadentate azodye ligand. Chemistry Africa.*
- *Drago, R. S. (2011). Physical methods in inorganic chemistry.*

Course Title: Physical Chemistry	L	T	P	Cr.
Course Code: MCH2452	4	0	0	4

Total hours: 60

Learning Outcomes

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

1. **Understand Chemical Thermodynamics** – Explain thermodynamic laws, state functions, phase equilibria, and the behavior of gases and solutions.
2. **Apply Statistical Thermodynamics** – Use Boltzmann distribution, partition functions, and kinetic theory to relate microscopic and macroscopic properties.
3. **Analyze Electrochemical Systems** – Interpret redox reactions, electrochemical cells, ionic conductance, and perform conductometric and potentiometric titrations.
4. **Evaluate Chemical Kinetics** – Determine reaction mechanisms, apply rate laws, and understand theories of reaction rates, enzyme kinetics, and photochemical reactions.

Course Contents

UNIT I **15 hours**

Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.

UNIT II **12 hours**

Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.

UNIT III **16 hours**

Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.

UNIT IV **17 hours**

Chemical kinetics: Empirical rate laws and temperature dependence;

complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions.

Transaction Mode- Open Talk, Group Discussion, Video Based Teaching, Quiz, E Team Teaching, Collaborative Teaching, Peer Teaching, Case Analysis, Role- Playing, Ted Talks, Flipped Teaching

SUGGESTED READINGS

- **P.W. Atkins & J. de Paula** – *Physical Chemistry* (Oxford University Press)
- **G.W. Castellan** – *Physical Chemistry* (Pearson)
- **I. Prigogine & R. Defay** – *Chemical Thermodynamics* (Longmans)
- **R.P. Rastogi & R.R. Mishra** – *An Introduction to Statistical Thermodynamics* (New Age International)
- **T.L. Hill** – *Introduction to Statistical Thermodynamics* (Dover)
- **A.J. Bard & L.R. Faulkner** – *Electrochemical Methods: Fundamentals and Applications* (Wiley)
- **D.R. Crow** – *Principles and Applications of Electrochemistry* (Chapman & Hall)
- **K.J. Laidler** – *Chemical Kinetics* (Pearson)
- **P.W. Atkins & J. de Paula** – *Atkins' Physical Chemistry* (Oxford University Press)
- **R.A. Alberty & R.J. Silbey** – *Physical Chemistry* (Wiley)

Course Title: Heterocyclic Chemistry	L	T	P	Cr.
Course Code: MCH2453	4	0	0	4

Total hours: 60

Learning Outcomes

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

1. Study of heterocyclic chemistry: Five and six members heterocyclic with one or two hetero atoms.
2. Understand condensed five and six member's heterocyclic
3. Study the synthesis, reactivity, aromatic character and importance of heterocyclic compounds essential for medicinal purposes.
4. Learn structure of small ring heterocyclic members

Course Content

UNIT I **17 hours**

Nomenclature of Heterocycles

Systematic nomenclature (Hantzsch-widman System) for monocyclic fused and bridged hetrocycles

Aromatic Heterocycles

General chemical behaviour of aromatic heterocycles classification (structural type) criteria of aromaticity (bond length ring current and chemical shift in H NMR- Spectra), Diamagnetic susceptibility exaltations.

UNIT II **13 hours**

Non- aromatic Heterocycles

Strain-bond angle and torsional strains and their conseqences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular Geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interaction. Stereo-electronic effects- anomeric and related effects Attractive interactions-hydrogen, bonding and intermolecular nucleophilic-electrophilic interactions

UNIT III **16 hours**

Heterocyclic synthesis

Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition Reactions.

Small Ring Heterocycles

Three- membered and four-membered heterocycles- synthesis and reactions of aziridinesoxiranes, thiiranes, azetidines, oxetanes and thietanes

UNIT IV **14 hours**

Benzo-Fused Five-Memberd Heterocycles

Synthesis and reaction including medicinal applications of benzopyrroles, benzofurans and benzothiophenes

Six-Membered Heterocycles

One Heteroatom Synthesis and reactions of pyrylium salt and pyrones and their comparison with Pyridinium & thiopyrylium salt and Pyridones synthesis and reactions of Quinolizinium and benzopyrylium salt coumarins and chromones**.**

Transaction Mode Quiz, E-Team Teaching, Group Discussion, Demonstration

SUGGESTED READINGS

- Joule, J. A., & Mills, K. (2010). *Heterocyclic Chemistry* (5th ed.). Wiley.
- Joule, J. A., & Mills, K. (2007). *Heterocyclic Chemistry at a Glance* (1st ed.). Wiley-Blackwell.
- Gilchrist, T. L. (1997). *Heterocyclic Chemistry* (3rd ed.). Longman.

Course Title: Physical Chemistry Lab	L	T	P	Cr.
Course Code: MCH2454	0	0	4	2

Total hours: 60

Learning Outcomes

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

1. Determine the values of physical quantities.
2. Get hands on experience of operational know how the state of the art instruments helps in future industrial laboratory activities.
3. Derive rate constants that were taught in theoretical class, thereby develops coherence between the two.
4. Determine the concentration of unknown compounds through established experiments.

Course Content

Spectrophotometry, pH metry, Polarimetry, Conductometry & Colorimetry Instrument Analysis

1. To determine the Molecular weight of given polymer by viscosity method.
2. Determine the interfacial tension between two immiscible solvents.
3. To determine the rate constant of the hydrolysis of ethyl acetate catalyzed by an acid and also find out the half-life period of their action.
4. To find out the molar refractivity of the given solid.
5. Determine the specific rotation of an optically active compound.
6. Study the kinetics of inversion of cane sugar by polarimetry.
7. Estimate the strength of the strong acid and the weak acid in a mixture by conductometric titration.
8. To study the adsorption of acetic acid on activated charcoal & prove the validity of Freundlich Adsorption Isotherm.
9. Estimate the strength of a weak acid (monobasic/dibasic) pH-metrically. Find pKa of this acid at room temperature using a graphical procedure.
10. Study the kinetics of the reaction (KI + $K_2S_2O_8$) by colorimetric method and determine the rate constant of the reaction at room temperature.
11. Test the validity of Lambert-Beer's law for $KMnO_4$ solution. Construct similarly the calibration curve for $K_2Cr_2O_7$ solution and hence determine the concentration of an unknown $K_2Cr_2O_7$ solution.
12. Study the kinetics of iodination of acetone in presence of acid. Hence find out the order with respect to iodine/acetone/acid.
13. Determine the critical solution temperature of phenol-water system.
14. To find out the molecular weight of benzoic acid in benzene cryoscopically

hence find out its degree of association.

15. To determine the density of given liquids with the help of Pyknometer.

Note: Each student is required to perform at least ten experiments.

Transaction Mode- Team Teaching, Demonstration, Open Talk, Collaborative Teaching, Group Discussion, Video Based Teaching, Quiz, E Team Teaching, Case Analysis

SUGGESTED READINGS

- *Mann and Saunders. (2009). Practical organic chemistry, Pearson, 4th edition, UK.*
- *Vogel, A. I., Mendham, J., Denney, R. C., Barnes, J. D., & Thomas, M. (2009). Vogel's quantitative chemical analysis. Pearson.*
- *Findary, A. Kitchner, T. A., Practical physical chemistry, Longmans, Green and Co.*
- *J. M. Wilson, K. J. Newcombe, A. R. Denko, R. M. W. Richett, Experiments in Physical Chemistry, (Pergamum Press).*

Course Title: Industrial Chemistry	L	T	P	Cr.
Course Code: MCH2455	2	0	0	2

Total hours: 45

Learning Outcomes

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

1. Cope up with environmental issues for large scale production of gases and chemicals by appropriate modern methods.
2. Apply the principles of diffusion & mass transfer to various systems.
3. Diagnose the construction & working of various equipments used in distillation, extraction, leaching, drying, absorption and filtration and purification methods.
4. Analyze different type of model to understand air pollution.

Course Content

UNIT I **8 hours**

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the followinggases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, Sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

UNIT II **8 hours**

Industrial Metallurgy: Crushing and grinding, Gravity separation, Froth flotation, Magnetic separation, Leaching methods, Extraction of Metals: Pyrometallurgical processes: Roasting, Calcination, Smelting, Hydrometallurgical processes: Cyanide leaching, Acid leaching, Ammonia leaching, Electrometallurgical processes.

UNIT III **7 hours**

Environment and its segments: Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by SO2, CO2, CO, NOx, H2S and other foul smelling gases Methods of estimation of CO, NOx, SOx and control procedures removal of Sulphur from coal.Control of particulates

UNIT IV **7 hours**

Water Pollution: Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.

Transaction Mode- Open Talk, Video Based Teaching, Group Discussion, Quiz, E Team Teaching, Collaborative Teaching, Case Analysis, Peer Teaching, Role- Playing, Ted Talks, Flipped Teaching

SUGGESTED READINGS

- *R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.*
- *J. A. Kent: Riegel's handbook of industrial chemistry, CBS Publishers, New Delhi.*
- *S. S. Dara: A Textbook of Engineering chemistry, S. Chand & Company Ltd. NewDelhi.*
- *K. De, Environmental chemistry: New Age International Pvt., Ltd, New Delhi.*

Course Title: Biology for Chemists	L	T	P	Cr.
Course Code: MCH2456	4	0	0	4

Total hours: 60

Learning Outcomes

After the completion of the course, the students will be able to

1. Acquire understanding about cell and its functions.
2. Estimate ultra-structure of cell wall, plasma membrane and organelles.
3. Acquire knowledge of Food chain and food web in ecosystem.
4. Evaluate information relevant to hereditary and genetic issues.

Course Content

UNIT I **15 hours**

Cell Structure, Functions and divisions

Structure of prokaryotic. & eukaryotic cells, Intercellular organelles and their functions, Comparison of plant and animal cells. Overview of metabolic process-catabolism and Anabolism. ATP- the Biological energy currency. Cell divisions tags of mitosis &meiosis. Significance of cell division and fertilization.

UNIT II **15 hours**

Carbohydrates: Mono saccharine, structure & functions Structural poly saccharine. Structural Polysaccharide-cellulose and chitin. Storage Polysaccharides-starch and glycogen. Lipids, Fatty acids, essential fatty acids, structure and function. Storage lipids. Biological membranes and transport. Fluid mosaic model of membrane structure.

UNIT III **15 hours**

Structure of Proteins Amino acids, essential and non-essential, Primary structure –peptide chain. Secondary structure ofproteins, for case response before holding of secondary structure-αhelix, beta sheets

UNIT IV **15 hours**

Enzymes: Enzymes as biological catalyst and mode of their action.,Structure of Nucleic Acids Structure of ribonucleic acids (RNA) and dioxin ribonucleic acids (DNA), Replication of DNA: The chemical basis of heredity and over view of replication of DNA, protein synthesis &Genetic Code,transcription, translation and genetic code, chemical synthesis of mono,di,tri nucleotide.

Transaction Mode- Open Talk, Flip Teaching, Cooperative Teaching, Role Play

SUGGESTED READINGS

- *Nelson, D. L., Lininger, A. L., & Cox, M. M. (2018). Lininger principles of biochemistry. Macmillan.*
- *Berg, J. M., Tymoczko, J. L., &Stryer, L. (2016). Biochemistry WH Freeman and Company. New York.*
- *Vella, F. (1993). Principles of biochemistry by HR Horton, LA Moran, RS Ochs, JD Rawn and KG Scrimgeour. pp 675. Neil Patterson Publishers, Prentice Hall Inc.*

Course Title: Chemistry of Natural Products	L	T	P	Cr.
Course Code: MCH2457	4	0	0	4

Total hours: 60

Learning Outcomes

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

1. Analyze the structure and stereochemistry of hardwickiic acid, camptothecin and podothyllotoxin.
2. Design the synthesis of taxol, astrin and pristone, free teeramycin A.
3. Evaluate biogenesis terpenoides, alkaloids pathway.
4. Estimate the antibiotics and their medicinal uses studied essential for drug synthesis.

Course Content

Unit –I **16 hours**

Studies on Biosynthetic Pathways of Natural Products Structure and Synthesis of some natural products based on chemical and spectroscopic methods The acetate hypothesis, poly-ketoacids, their addol type cyclisations and meta orientations of hydroxyl groups in naturally occurring phenols. b) Isoprene rule, mechanism of formation of mevalonic acid from acetyl coenzyme, Biogenetic isoprene rule. Geranyl pyrophosphates and its conversion into alphapinene, thujene and borneol. Farnesyl pyrophosphate, geranyl, geranyl pyrophosphate and mechanistic considerations for their interconversions into cadinene and abietic acid.

Unit –II **14 hours**

Terpenoids: General classification, General Methods of structure determination, Chemistry of Camphor, Abietic acid, Ascorbic Acid, Pinene and Longofolein, Santonin biosynthetic studies on tri and tetra terpenoids.

Steroids: General biosynthetic studies on steroids, chemistry of Cholesterol, cortisone, progesterone, oestrone, transformations in steroid molecules

Unit –III **15 hours**

Alkaloids: Classification, chemistry of nicotine, quinine, papaverine, morphine and reserpine

Haemin and Chlorophyll: Structure and synthesis of Porphyrins. Chemistry of Haemin and chlorophyll

Unit –IV **15 hours**

Antibiotics: Introduction, chemistry of pencillins, streptomycines, chloromphenicol, tetracycline

Prostaglandins: General study, nomenclature, structure of PGE and synthesis of PGE1, PGE2, PGF2x.

Transaction Mode- Video Based Teaching, Open Talk, Group Discussion, Quiz, E Team Teaching, Collaborative Teaching, Case Analysis, Role-Playing, Ted Talks, Flipped Teaching

SUGGESTED READINGS

- *Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann, M., & amp; Grimes, R. (2018). Advanced inorganic chemistry (Vol. 6, p. 1455). New York: Wiley.*
- *Shriver, D. F., Atkins, P. W., & Langford, C. H. (1999). Inorganic chemistry.*
- *Hughes, M. N. (2011). The inorganic chemistry of biological processes 2nd edn. FEBS LETTERS.*

Semester: III

Course Title: Basics of Research Methodology	L	T	P	Cr.
Course Code: MCH3500	4	0	0	4

Total hours: 60

LEARNING OUTCOMES

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

1. Assess concept of research, its types, methodology to formulate research problem effectively.
2. Identify disposable explosive and their verification and segregation.
3. Explain the data obtained during investigation and their further analysis.
4. Develop research oriented skills.

Course Content

UNIT I **16 hours**

Research: Concept, nature, scope, need and objectives of research. Research types, Research methodology, Research process – Flow chart, description of various steps, Selection of research problem.

Research Design: Meaning, objectives and strategies of research, different research designs, important experimental designs.

UNIT II **14 hours**

Methods of Data Collection and Presentation: Types of data collection and classification, The Investigative Approach, Making and Recording Measurements, SI Units and their use. Descriptive statistics, Selection and use of statistical tests

UNIT III **16 hours**

Analysis and Presentation of Data: Chemo metrics. 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 use. Basic aspects of multiple linear regression analysis

UNIT IV **14 hours**

Report writing and Presentation: Types of reports, Report Format –Cover page, Introductory page, Text, Bibliography, Appendices, Typing instructions, Oral Presentation

Transaction Mode- Group Discussion, Collaborative teaching, Peer Teaching, Video Based Teaching, Quiz, Open talk, E team Teaching, Case analysis, Role-Playing, Ted talks, Flipped Teaching

SUGGESTED READINGS

- *Practical skills in chemistry. 2nd Ed. Prentice-Hall, Harlow.*
- *Hibbert, D. B. & Gooding, J. J. (2016) Data analysis for chemistry. Oxford University Press.*
- *Topping, J. (2011) Errors of observation and their treatment. Fourth Ed., Chapman Hall, London.*
- *Harris, D. C. Quantitative chemical analysis. 6th Ed., Freeman (2017) Chapters 3- 5.*
- *Levie, R. de, How to use excel in analytical chemistry and in general scientific dataanalysis. Cambridge Univ. Press (2015) 487 pages.*
- *Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992. OSU safety manual 1.01.*
- *Panneerselvam, R, 'Research methodology', PHI, New Delhi.*
- *Cooper, D.R.,Schindler,P.S., Business research methods,' Tata McGraw Hill.*
- *Gupta S P, Statistical methods, Sultan Chand & Sons, Delhi.*
- *Ronald E Walpole, Probability and statistics for engineers and scientists (International Edition) , Pearson Education.*
- *Geode, Millian J. & Paul K. Hatl, Methods in research, McGraw Hills, New Delhi.*

Course Title: Polymer Chemistry	L	T	P	Cr.
Course Code: MCH3501	4	0	0	4

Total hours: 60

Learning Outcomes:

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

1. Explain adsorption process and its mechanisms beneath surfaces.
2. Apply the use of catalyst to alter new path for chemical reactions.
3. Gain insights about Colloids and how to destabilize dispersed phase particles.
4. Determine the molecular weight of polymers.

Course Content

UNIT I **12 hours**

Adsorption

Surface tension, capillary action, pressure difference across curved surface (Laplace equations), vapor pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electro-kinetic phenomena), catalytic activity at surfaces.

UNIT II **08 hours**

Micelles

Surface active agents, classification of surface active agents, micellization, hydrophobic interactions, critical micellar concentration (CMC), factors affecting CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization – phase separation and mass action models, solubilization, micro emulsion, reverse micelles.

UNIT III **14 hours**

Macromolecules Basic concepts: Polymer **–** definition, types of polymers, electrically conducting, fire resistant, liquids crystal polymers, kinetics of polymerization, monomers, repeat units, degree of polymerization. Linear, branched and network polymers.

Classification of polymers: Polymerization, its types condensation, addition, radical chain- ionic and co-ordination and copolymerization. Polymerization conditions and polymer reactions, Polymerization in homogenous and heterogeneous systems, chain configuration of macromolecules, calculations of average dimensions of various chain structures

Polymer Solution – Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy

change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

UNIT IV **11 hours**

Properties (Physical, Thermal, Flow & Mechanical Properties) and Applications of Polymers:

Crystalline melting point Tm- melting point of homogenous series, effect of chain flexibility and steric factors

Glass transition temperature (Tg) and determination of Tg, , Factors affecting glass transition temperature (Tg)-effects of molecular weight, diluents, chemical structure & Morphology of Polymer , chain topology, branching and chain linking. Property requirements and polymer utilization Structure, Properties and applications of polyolefins, polystyrene and styrene copolymers, poly (vinyl chloride) and related polymers, poly (vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly (p-phenylene sulphide polypyrrole, polythiophene)].

Transaction Mode- Group Discussion, Open Talk, Video Based Teaching, Quiz, E Team Teaching, Collaborative Teaching, Case Analysis, Peer Teaching, Role- Playing, Ted Talks, Flipped Teaching

SUGGESTED READINGS

- *Text book of polymer science, F. W. Billmeyer Jr. Wiley.*
- *Seymour's Polymer chemistry, Marcel Dekker, Inc.*
- *G. Odian: Principles of Polymerization, John Wiley.*
- *F.W. Billmeyer: Text book of polymer science, John Wiley.*

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Course Title: Service Learning	L	T	P	Cr.
Course Code: MCH3502	0	0	4	2

Learning Outcomes

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

1. Participate in community activities to establish connections and build relationships.
2. Evaluate community needs through conversations with community members.
3. Develop and implement initiatives that address community needs.
4. Reflect on personal growth, community impact and ethical considerations related to service activities.

Course Content

This course aims to engross students in meaningful service-learning activities that foster community linking. Students will actively participate in community-based projects, collaborate with community members and organizations and reflect on the impact of their service activities. Through this experiential learning approach, students will develop a deep understanding of community needs, build relationships with diverse stakeholders and contribute to community development.

In this course, students are expected to be present in the community throughout the semester and reflect on their experiences regularly after working with them. The students will use experiential learning for providing service learning. They will be able to analyse and have understanding of the key theoretical, methodological and applied issues.

Select 10 community related activities which are to be performed in nearby villages. Students in groups of 8-10 shall work on one activity.

Evaluation Criteria

1. Every activity shall be evaluated on the same day out of 10 marks.
2. Total 10 activities out of 100 shall be evaluated and submitted to Examination branch.

Activity Evaluation

1. Type of activity- 2 marks
2. Participation of student- 2 marks
3. Engagement in the activity- 2 marks
4. Outcome of the activities- 2 marks

5. Attendance- 2 marks

Transaction Mode

Problem-solving learning, Blended learning, Gamification, Cooperative learning, Inquiry-based learning, Visualization, Group discussion, Experiential learning, Active participation.

Course Title: Supramolecular Chemistry	L	T	P	Cr.
Course Code: MCH3503	4	0	0	4

Total hours: 60

Learning Outcomes

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

1. Recognize the fundamentals of supramolecules and the simultaneous action of several non covalent interactions
2. Gain insight about co-receptor molecules and multiple recognition.
3. Analyze the challenges in supramolecular reactivity and catalysis.
4. Evaluate the role of various supramolecular devices and concepts of supramolecular chemistry in sensing and separation technologies.

Course Contents

UNIT I **15 hours**

Concepts of Supramolecular Chemistry

Concepts and languages of supramolecular chemistry – various types of non-covalent interactions – hydrogen bonds, C-H X interactions, halogen bonds – π-π interactions, non– bonded interactions – various types of molecular recognition. Crystal engineering of organic solids – hydrogen bonded involving water / carboxyl / halide motifs – concepts of different types of synthons based on non- covalent interactions – principles of crystal engineering and non-covalent synthesis– polymorphism and pseudo polymorphism – supramolecular isomorphism / polymorphism.

UNIT II **15 hours**

Metallo Organic Frameworks

M.O.F (Metallo Organic Frameworks) – organometallic systems – combinations of different interactions to design molecular rods, triangles, ladders, networks, etc. – design of nanoporous solids – inter ligand hydrogen bonds in metal complexes

Co-receptor Molecules and Multiple Recognition: Dinuclear and polynulclear metal ion cryptates – linear recognition of molecular length by ditopic co-receptors – heterotopic co-receptors – cyclophane receptors, amphiphilic receptors and large molecular cages – multiple recognition in metalloreceptors – supramolecular dynamics

UNIT III **15 hours**

Supramolecular Reactivity and Catalysis

Catalysis by reactive macrocyclic cation receptor molecules – catalysis by reactive anion receptor molecules – catalysis with cyclophane type receptors – supramolecular metallocatalysis – cocatalysis – catalysis of synthetic reactions – biomolecular and abiotic catalysis.

UNIT IV **15 hours**

Supramolecular Devices

Supramolecular devices and sensors: various types of devices, an overview, supramolecular photochemistry; molecular and supramolecular photonic devices: light conversion and energy transfer devices; molecular and supramolecular electronic devices; electronic conducting devices; molecularwires, modified and switchable molecular wires. Molecular and supramolecular ionic devices, switching device: electro-photo switch; ion and molecule sensors role of supramolecular chemistry in the development of nanoscience and technology.

Transaction Mode- Open Talk, Video Based Teaching, Group Discussion, Quiz, E Team Teaching, Collaborative Teaching, Peer Teaching, Role-Playing, Ted Talks, Flipped Teaching

SUGGESTED READINGS

- *J. M. Lehn, Supramolecular chemistry; VCH, Weinheim, Germany, 1995.2.*
- *R. Desiraju, Crystal engineering: The design of organic solids; Elsevier, United States, 198*
- *R. Desiraju, and T. Steiner, The Weak Hydrogen bond in structural chemistry and biology; Oxford University Press, Oxford, 1999.*

Course Title: Chemistry of Cosmetics & Perfumes	L	T	P	Cr.
Course Code: MCH3504	4	0	0	4

Total hours: 60

LEARNING OUTCOMES

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

1. Prepare Cosmetic Products
2. Identify artificial flavors.
3. Make lipstick of required choice.
4. Learn the composition of natural essential oils and their uses.

Course Content

UNIT I **15 hours**

Preparation and uses of the following:

Hair dye, hair spray, shampoo

UNIT II **15 hours**

Preparation and uses of the following:

Face and body lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishingand shaving creams).

UNIT III **15 hours**

Preparation and uses of the following:

Antiperspirants and artificial flavours. Essential oils and theirimportance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oileucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone

UNIT IV **15 hours**

Preparation and uses of the following:

Nail polish and nail polish remover, hair remover Cream

Transaction Mode- Group Discussion, Video Based Teaching, Quiz, Open talk, E team Teaching, Collaborative teaching, Peer Teaching, Case analysis, Role- Playing, Ted talks, Flipped Teaching

SUGGESTED READINGS

- Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK (1990).
- Jain, P.C. & Jain, M. *Engineering Chemistry* Dhanpat Rai & Sons, Delhi.
- Sharma, B.K. & Gaur, H. *Industrial Chemistry,* Goel Publishing House, Meerut(1998)

Course Title: Pesticide Chemistry	L	T	P	Cr.
Course Code: MCH3505	4	0	0	4

Total hours: 60

Learning Outcomes

After completion of the course, the learner willbe able to

1. Synthesize useful pesticides.
2. Prepare of simple organophosphates.
3. Calculate alkalinity of various pesticides.
4. Identify adverse effect of pesticides.

Course Content

UNIT I **14 hours**

General introduction to pesticides (natural and synthetic), benefits and adverse effects.

UNIT II **15 hours**

Changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and uses of representative pesticides.

UNIT III **15 hours**

Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuranand carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).

UNIT IV **16 hours**

Preparation of simple organophosphates, phosphonates and thiophosphates and Calculate acidity/alkalinity in given sample of pesticide formulations as per BIS specifications.

Transaction Mode Open Talk, Flip Teaching, Cooperative Teaching,Role Play

SUGGESTED READINGS

- Cremlyn, R. *Pesticides. Preparation and Modes of Action*, John Wiley & Sons, NewYork, 1978.

Course Title: Green Chemistry	L	T	P	Cr.
Course Code: MCH3506	4	0	0	4

Total hours: 60

Learning Outcomes

After completion of the course, the learner willbe able to

1. Explore the basic principle of green chemistry and their contemporary importance.
2. Design and develop less hazardous and environmental friendly chemicals.
3. Cope with the less eco-friendly discharge from chemical reactions.
4. Evaluate the mechanism of solventless reactions.

Course Content

UNIT I **10 hours**

Introduction to Green Chemistry

Meaning of Green Chemistry, Need for Green Chemistry. Goals of Green Chemistry; Limitations/ Obstacles in the pursuit of the goals of Green Chemistry

UNIT II **18 hours**

Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples and special Emphasis After following:

- Designing a Green Synthesis using these principles; Prevention of Waste/ by products maximum incorporation of the materials used in the process into the final products, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.
- Prevention/ minimization of hazardous/ toxic products reducing toxicity.
- Risk = (function) hazard × exposure; waste or pollution prevention hierarchy.
- Green solvents– supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solvent less processes, immobilized solvents and how to compare greenness of solvents.
- Energy requirements for reactions – alternative sources of energy: use of microwaves and ultrasonic energy.
- Selection of starting materials; avoidance of unnecessary derivatization careful use of blocking/protecting groups.
- Use of catalytic reagents (wherever possible) in preference to

stoichiometric reagents; Catalysis and green chemistry, comparison of heterogeneous and homogeneous

- Catalysis, biocatalysts, asymmetric catalysis and photocatalysis.
- Prevention of chemical accidents designing greener processes, inherent safer design,
- Principle of ISD "What you don't have cannot harm you", greener alternative
- Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer Route to cyclohexane) subdivision of ISD, minimization, simplification, substitution, Moderation and limitation.
- Strengthening/ development of analytical techniques to prevent and minimize the Generation of hazardous substances in chemical processes.

UNIT III **17 hours**

Examples of Green Synthesis/ Reactions and some real world cases

- Green Synthesis of the following compounds: Adipic acid, catechol, disodium Iminodiacetate (alternative to Stracke synthesis)
- Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents
- Diels-Alder reaction and Decarboxylation reaction
- Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic Alternative to Iodine)
- Surfactants for carbon dioxide – replacing smog producing and ozone depleting Solvents with CO2 for precision cleaning and dry cleaning of garments.
- Designing of Environmentally safe marine antifoulant.
- Right fit pigment: synthetic azopigments to replace toxic organic and inorganic Pigments.
- An efficient, green synthesis of a compostable and widely applicable plastic (poly Lactic acid) made from corn.
- Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for Production of no Trans-Fats and Oils
- Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting

UNIT IV **15 hours**

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

Transaction Mode- Group Discussion, Open Talk, Video BaseTeaching, Quiz, E Team Teaching, Collaborative Teaching, Case Analysis, Peer Teaching, Role-Playing, Ted Talks, Flipped Teaching

SUGGESTED READINGS

- *Ahluwalia, V.K. & Kidwai, M.R. (2015). New trends in Green Chemistry, Anamalaya Publishers*
- *Matlack, A.S. (2011. Introduction to green chemistry, Marcel Dekker.*
- *Cann, M.C. & Connely, M.E. (2012). Real-World cases in green chemistry, American Chemical Society, Washington.*
- *Ryan, M.A. & Tinnesand, M. (2015). Introduction to green chemistry, American Chemical Society, Washington*

Course Title: Chemistry of Cosmetics & Perfumes	L	T	P	Cr.
Course Code: MCH3507	4	0	0	4

Total hours: 60

Learning Outcome

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

1. Apply the fundamental knowledge in kinetics, dynamic electrochemistry to existing and emerging problems of basic sciences
2. Develop problem solving ability in kinetics and dynamics electrochemistry
3. Get deep insights to fundamentals of electro analytical chemistry and types of electro analytical methods.
4. Demonstrate the applications of the voltametry and polarographic methods as a tool in analytical sciences.

Course Content

UNIT I **15 hours**

Chemical Dynamics-I

Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius theory and activated complex theory, ionic reactions, kinetic salt effects, treatment of uni molecular reactions, Lindemann- Hinshelwood theory.

UNIT II **11 hours**

Chemical Dynamics-II

Dynamic Chain (hydrogen bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), Photochemica lreactions between hydrogen-bromine and hydrogen-chlorine, oscillatory reactions (Belousov-Zhabotinsky reactions), Homogeneous catalysis and kinetics of enzyme reactions, general features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis, nuclear resonance.

UNIT III **13 hours**

Polarography

Polarography, polarographic cells, polarogram, interpretation of polarographic waves, equation for the polarographic waves, effect of complex formation on polarographic wave, polarograms for irreversible reactions, dropping mercury electrode, current variations during life time of a drop, merits and demerits of dme, polarographic diffusion currents, Ilkovic equation, capillary characteristics, temperature, polarograms for mixture of reactants, anodic and cathodic waves, factors affecting polarographic currents, applications of polarography.

UNIT IV **09 hours**

Voltammetry

voltammetry at solid electrodes, cyclic voltammetry and interpretation of data, pilot-ion and standard addition method for quantitative analysis

Transaction Mode- Open Talk, Video Based Teaching, Group Discussion, Quiz, E Team Teaching, Collaborative Teaching, Peer Teaching, Role-Playing, Ted Talks, Flipped Teaching

SUGGESTED BOOKS

- *Chemical kinetics, K. J. Laddler, McGraw-Hill*
- *Modern electrochemistry1,2A, and 2B. Springer US.*
- *Modern electrochemistry Vol.1,2,3, J. Bochris and A.K.N. Reddy*
- *Fundamentals of electrochemistry; P. Monk*

Course Title: Biophysical Chemistry	L	T	P	Cr.
Course Code: MCH3508	3	0	0	3

Total hours: 45

Learning Outcomes

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

1. Account for structures and functions of biological membrane, as well as model systems and relevant methods.
2. Describe how anabolic and catabolic processes are coupled to energetic from ATP hydrolysis
3. Identify enzymes involved in metabolic pathways.
4. Explain biosensors and their industrial applications.

Course Content

UNIT I **10 hours**

BIOENERGETICS: Standard free energy, entropy and chemical potential change in biochemical reactions, the effect of temperature and pH Oxidation, reduction reaction and hydrolytic reactions in biological system (electron-transfer reactions).

UNIT II **13 hours**

PROPERTIES OF WATER: Ionic product of water and its measurements, Importance of water in biological system with special reference to the maintenance of the native structure of biological molecules, Types of bonding in biological molecules, Biological relevance of pH and pKa proteins and nucleic acids, Buffers, pH value of various bio-entities, buffer action, buffer capacity and their importance in biological systems. Isoelectric points for amino acids.

UNIT III **12 hours**

Forces involved in biopolymer interaction. Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interaction. Thermodynamics of biopolymers. Vant's Hoff's law of osmotic pressure, Theory of osmotic pressure and semipermiability. Significance of osmosis in biology

UNIT IV **10 hours**

TRANSPORT OF ION: Ion transport through cell membrane, nurve conduction

BIOSENSORS: Definition, types, sensors for environmental, medical, food

safety and biosecurity applications

Transaction Mode- Group Discussion, Video Based Teaching, Quiz, Open talk, E team Teaching, Collaborative teaching, Peer Teaching, Case analysis, Role- Playing, Ted talks, Flipped Teaching

SUGGESTED READINGS

- *Timberlake, K. C., &Orgill, M. (2009). Chemistry: An introduction to general, organic, and biological chemistry. Pearson/Prentice Hall.*
- *Wurst, F. M., Alexson, S., Wolfersdorf, M., Bechtel, G., Forster, S., Alling, C., & Pragst, F. (2004). Concentration of fatty acid ethyl esters in hair of alcoholics: comparison to other biological state markers and self reported-ethanol intake. Alcohol and Alcoholism.*

SEMESTER-IV

Course Title: Dissertation	L	T	P	Cr.
Course Code: MCH4550	0	0	0	20

Guidelines for Dissertation:

The purpose of the dissertation in M.Sc. 4th semester is to introduce research methodology to the learner. It may consist of a review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem related to the subject, participation in some ongoing research activity, analysis of data, etc. The work can be carried out in any thrust areas of the subject (Experimental or Theoretical) under the guidance of the allotted supervisor of the department. The learner must submit their dissertations in the department as per the date announced for the submission**.**

Internal assessment of the dissertation work will be carried out by the respective supervisor through power point presentation given by candidates during the semester. External assessment of the dissertation work will be carried out by an external examiner (nominated by the Chairperson of the Department) through a power-point presentation given by candidates. This load (equivalent to 2 hours per week) will be counted towards the normal teaching load of the teacher.

- Dissertation will contain a cover page, certificate signed by student and supervisor, table of contents, introduction, Objective, Literature review, methodology, results and discussions, conclusion, and references.
- Paper size to be used should be A-4 size.
- Font size should be 12 with Times New Roman.
- Text of the dissertation may be typed in 1.5 (one and a half) space.
- Print out of the dissertation shall be done on both sides of the paper (instead of single side printing)
- Total no. of written pages should be between 40 to 60 for the dissertation.
    1. The candidate shall be required to submit two soft-bound copies of the dissertation along with a CD in the department as per the date announced.
    2. Dissertation will be evaluated internally by the supervisor allotted to the student during the semester.
    3. The candidate will defend her/his dissertation/project work through a presentation before the external examiner at the end of the semester and will be awarded marks.
    4. In case, a student is not able to score passing marks in the dissertation

exam, he/she will have to resubmit her/his dissertation after making all corrections/improvements & this dissertation shall be evaluated as above. The candidate is required to submit the corrected copy of the dissertation in hardbound within two weeks after the viva -voce.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E-team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Course Title: Nanotechnology	L	T	P	Cr.
Course Code: MCH4551	4	0	0	4

Learning Outcomes

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

1. To introduce the fundamental principles of nanoscience and nanochemistry.
2. To explore the chemical synthesis, properties, and applications of nanomaterials.
3. To understand the role of size, shape, and surface effects at the nanoscale.
4. To develop an appreciation for nanotechnology in modern applications including medicine, energy, and materials.

Unit I **15 hours**

Introduction to Nanochemistry and Nanomaterials: History and scope of nanochemistry**;** Concepts of nanoscale: nanometer, quantum size effects**,** Types of nanomaterials: zero-, one-, two-, and three-dimensional nanostructures**,** Surface area to volume ratio, surface energy**,** Classification: metal, metal oxide, carbon-based, polymeric nanomaterials

Unit II **15 hours**

Synthesis of Nanomaterials: Top-down vs. Bottom-up approaches, Chemical synthesis methods, Sol-gel, Co-precipitation, Hydrothermal and solvothermal, Microemulsion, Physical synthesis methods: Ball milling, Laser ablation, Chemical vapor deposition (CVD), Physical vapor deposition (PVD).

Unit III **15 hours**

Characterization of Nanomaterials: Techniques and instrumentation: X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), UV-Visible and FTIR spectroscopy, Particle size analysis and zeta potential

Unit IV **15 hours**

Applications and Ethical Aspects of Nanochemistry: Applications in: Drug delivery and nanomedicine, Energy (solar cells, batteries), Environmental remediation, Nano-catalysis, Risks and ethical concerns:Toxicity of nanoparticles, Environmental impact, Safety regulations and guidelines

Suggested Readings

1. **C. N. R. Rao, A. Müller, A. K. Cheetham** – *The Chemistry of Nanomaterials*
2. **Gabor L. Hornyak** – *Introduction to Nanoscience*
3. **T. Pradeep** – *Nano: The Essentials*
4. **K.K. Chattopadhyay & A.N. Banerjee** – *Introduction to Nanoscience and Nanotechnology*
5. **Mark Ratner, Daniel Ratner** – *Nanotechnology: A Gentle Introduction to the Next Big Idea*

Course Title: Scientific Research and Technical Writing	L	T	P	Cr.
Course Code: MCH4552	**2**	**0**	**0**	**2**

Learning Outcomes

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

1. To introduce students to the fundamentals of scientific research methodology.
2. To develop skills in literature review, data collection, analysis, and interpretation.
3. To train students in writing scientific reports, theses, and research papers.
4. To familiarize students with scientific ethics, plagiarism, and citation standards.

Course Outline

Unit I **07 hours**

Introduction to Scientific Research: Definition, objectives, and types of research**,** Research process: Selection and formulation of research problem**,** Review of literature and referencing tools**,** Research design and hypothesis formulation

Unit II **08 hours**

Technical Writing Skills: Features of technical writing: Clarity, coherence, and structure**,** Scientific terminology, units, and abbreviations**,** Writing abstracts, research papers, technical reports, dissertations, and theses**,** Formatting styles: APA, MLA, Chicago, ACS style

Unit III **07 hours**

Data Presentation and Interpretation: Tables, graphs, and charts – Preparation and interpretation**,** Use of software tools (Excel, Origin, ChemDraw, etc.)**,** Statistical analysis basics: Mean, SD, variance, t-test, chi-square

Unit IV **08 hours**

Ethics in Scientific Research: Research integrity and scientific misconduct**,** Plagiarism: Tools and prevention strategies (Turnitin, Grammarly, etc.)**,** Copyright and intellectual property rights**,** Institutional ethical guidelines and approvals (IRB, IPR)

Suggested Readings:

- Kothari, C.R., *Research Methodology: Methods and Techniques*
- Dawson, C., *Practical Research Methods*

- Day, R.A. & Gastel, B., *How to Write and Publish a Scientific Paper*
- Alley, M., *The Craft of Scientific Writing*
- Glantz, S.A., *Primer of Biostatistics*
- Levie, H.W., *Graphic Methods for Presenting Facts*
- Shamoo, A.E. & Resnik, D.B., *Responsible Conduct of Research*
- Resnik, D.B., *Ethics of Science: An Introduction*

Course Title: Chemistry of Main Group Elements, Theories of Acids and Bases	L	T	P	Cr.
Course Code: MCH4553	4	0	0	4

Learning Outcomes

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

1. Characterize the Basic concepts of operators likeSolution of algebraic and transcendental equations: Bisection method, False position method, Fixed-point iteration method.
2. Solve problems using Newton forward formula andNewton backward formula and its convergence.
3. Derive Gauss's formula and Stirling's formula using Newton forward formula and Newton backward formula.
4. Calculate Simpson's 1/3, 3/8 rules using trapezoidal rule and evaluate the summation of series finite difference techniques

Course Content

UNIT I **16 hours**

Acids and Bases Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

General Principles of Metallurgy Chief modes of occurrence of metals based on standard electrode potentials, Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agents. Hydrometallurgy with reference to cyanide process for gold and silver. Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn, Au): electrolytic refining, zone refining, vanArkel-de Boer process, Parting Process, Mond's process and Kroll Process.

UNIT II **17 hours**

s- and p-Block Elements Periodicity in s- and p-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electron gain enthalpy, electronegativity (Pauling scale). General characteristics of s-block metals like density, melting and boiling points, flame colour and reducing nature. Oxidation states of s- and p-block elements, inert-pair effect, diagonal relationships and anomalous behaviour of first member of each group. Allotropy in C, P and S Complex forming tendency of s block elements and a preliminary idea of crown ethers and cryptates, structures of basic

beryllium acetate, salicylaldehyde/acetylacetonate complexes of Group 1 metals. Solutions of alkali metals in liquid ammonia and their properties. Common features, such as ease of formation, solubility and stability of oxides, peroxides, superoxides, sulphates and carbonates of s-block metals. Structure, bonding and properties(acidic/ basic nature, oxidizing/ reducing nature and hydrolysis of the following compounds and their applications in industrial and environmental chemistry wherever applicable: Diborane and concept of multicentre bonding, hydrides of Groups 13 (EH3), 14, 15, 16 and 17.

UNIT III **14 hours**

Halides and oxo halides of P and S (PCl3, PCl5, SOCl2 and SO2Cl2) Interhalogen compounds.Rationalization of inertness of noble gases, clathrates, preparation and properties of XeF2, XeF4and XeF6, bonding in these compounds using VBT and shapes of noble gas compounds using VSEPR Theory.

UNIT IV **13 hours**

Inorganic Polymers Types of inorganic polymers and comparison with organic polymers, structural features, classification and important applications of silicates. Synthesis, structural features and applications of silicones. Borazines and cyclophosphazenes – preparation, properties and reactions. Bonding in (NPCl2)3.

Transaction Mode Collaborative teaching, Group Discussion, Ted talks,E team Teaching

Suggested Readings:-

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic InorganicChemistry, 3rd ed., Wiley.
3. 3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, JohnWiley & Sons.
4. 4. Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
5. 5. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

Course Title: Fuel Chemistry	L	T	P	Cr.
Course Code: MCH4554	4	0	0	4

Learning Outcomes

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

1. Classify different types of fuel and their utility in daily life.
2. Calculate the Calorific Value of Fuels.
3. Prepare different Petrochemicals.
4. Demonstrate different properties of lubricants.

Course Content

UNIT I **18 hours**

Review of energy sources (renewable and non-renewable). Classification of fuels and theircalorific value. Coal: Uses of coal(fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke. Coal gasification and Solvent Refining.

UNIT II **16 hours**

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, bio-gas, fuels derived from biomass), clean fuels.

UNIT III **11 hours**

Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives.

UNIT IV **15 hours**

Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solidand semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

Transaction Mode- Open Talk, Question, E-Team Teaching, Group Discussion

SUGGESTED READINGS

- Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (2010).
- Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi.
- Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (2016).